

Copper

Top Projects

With the ninth iteration of the Copper Top Projects report, we analyse 84 copper projects that are set to form >75% of new copper supply in the near future and account for c.US\$150 bn of capex. Our key takeaway: for the first time in four years, the incentive price to bring new projects online has increased dramatically, by c.35% yoy. More than 80% of the unapproved projects we analyse are uneconomic at current prices, which means prices need to climb higher. However, that rise is likely to be slower than we previously expected, owing to higher supply this year and next. We remain confident on demand given our expectation that China's growth will remain strong and EV demand will start to manifest in the next few years. We continue to favour equities that are well positioned to bring new projects online, vs. those that do not have attractive projects and will likely have to engage in M&A.

Deficit delayed, not denied

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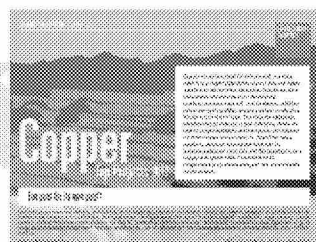
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The GS Supply Demand model for copper is a collaboration between our Equity and Commodities analysts. The views expressed outside this analysis are those of the equity analysts.

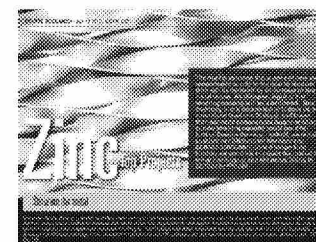
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COPPER in numbers



Top Projects takeaways

US\$7,067

average copper price required to generate a 17% IRR

US\$7,307

avg. incentive price to bring the 51 unapproved projects online

US\$6,799

avg. incentive price for the risked projects under our coverage

3%

average capital intensity of copper equivalent production in the last year



Supply Growth concentrated

50%

of the production increase in the next 2 years is coming from 3 mines

40%

of the new supply over the next 2 years is coming from 3 companies



Disruptions running low

1.10%

YTD rate of disruption vs. 5% through the cycle



Demand

2.90%

of demand growth in China pa over 2018-20E

3.50%

of demand growth in EMs pa over 2018-20E

0.50%

of demand growth in DMs pa over 2018-20E



Electric Vehicles

14%

EV/PHEVs as a % of the total fleet

21.8 mn tonnes

potential cumulative demand from EVs to 2030

PM Summary: Forecast deficit pushed out again

We update our analysis of the Top Projects: Copper set to come online in the near to medium term. The projects we analyse are set to form >75% of new production. After being a stellar performer for most of 2017 and early 2018, copper has sold off materially as investors have turned bearish on: (1) China demand; (2) EM concerns / stronger dollar and; (3) trade tensions. While prices have come off their peak in May/June this year, they remain strong, in our view. We believe the market continues to underestimate the lack of supply growth in copper, and therefore remain positive on the copper price.

In our 2017 edition, *Copper Top Projects: Too good for its own good*, we argued that the general attractiveness of the metal to all the stakeholders, has resulted in more supply coming online than expected. This has seen previously forecast deficits being pushed out - something which is happening with this report. However, post the work done in this report, we are confident that the lack of investment will see a deficit eventually forming in early 2020s.

On the demand side, we take a more upbeat view on China, and EMs more broadly, vs. the market; we remain confident that demand is likely to continue to grow in the next few years, barring a macro event such as that of 2007-08. Supporting this view is the work we have done with our commodities team on the potential demand from electric vehicles (EVs), which should provide a boost to demand in the early 2020s. While this is likely to be "out of investable time horizon" for some investors, we believe fundamental investors are likely to start to position positively on copper over the next few years given the expected increase in demand.

Key takeaways from our copper supply-side work

- **Costs/capex are on the rise...** Costs and capex demonstrated clear evidence of bottoming out in 2017. FY17/1H18 results showed that costs for global copper miners rose anywhere between 3% and 11% yoy, and capex between 3% and 5%. We believe this trend is here to stay.
- **...which has seen the incentive price required for projects increase:** Rising costs/capex, coupled with increasing consumable costs, has led to a rise in incentive prices – the copper price required to bring the projects we have analysed online – for the first time in four years. The incentive price for the 84 projects we have analysed has increased to US\$7,067/t, up 33% yoy.
- **Riskd projects relatively unchanged...** The parameters of the riskd projects that we analyse have remained relatively unchanged, mostly because the majority of the capex for these projects has already been spent. Our analysis of 33 riskd projects shows that the required price for the copper projects is c.US\$6,799/t, up from US\$5,073/t last year.
- **...while the required price for unapproved projects has increased significantly:** Of the 51 unapproved projects we have analysed, the required copper price has climbed to US\$7,307/t from US\$5,373/t, a yoy increase of 36%. Aside from

cost inflation/higher capex, this has been a function of higher risk, which in our view will lead to companies looking for a higher IRR.

Supply: Entering a period of very low growth on lack of investment over the past few years

- **Capex fell materially in 2015-17...** Investment in mining projects fell materially in 2015-17 as companies struggled to improve their balance sheets, which were highly levered. As the development period of a new mine is 3-5 years, the new mine supply that should have hit in 2018-20 will be pushed out, which means supply growth over the next few years is likely to be the lowest in several years – 2.33% pa over the next three years.
- **Lack of any tangible disruptions has been negative for prices...** One factor that has surprised both us and investors has been the lack of any tangible disruptions despite more than 2 mn tonnes of supply in Chile undergoing wage negotiations. This has been a function of companies reaching common ground with unions to avoid large-scale disruptions such as that of 2017.
- **...unlikely to be a consistent factor:** While the lack of disruptions has been a negative for copper prices, if history is a guide, it is unlikely to persist. Historically, the rate of disruptions has been c.5% of mine supply vs. 1.1% YTD. We believe mean-reversion is likely, which should affect supply from next year onwards.
- **Companies are still not investing in projects...** Despite copper prices having improved materially from the bottom of the cycle in 2016, mining companies are still wary of investing in growth projects. Indeed, the only greenfield project to be approved over the past couple of years has been Quellavaco (by Anglo American). We believe this is because: (1) companies remain wary of the volatility in commodity prices; and (2) investors are looking for enhanced returns and are still cautious on companies making large investments.
- **...which likely means prices need to remain higher for longer:** Given the dampening effect on investment of recent volatility in prices (which is positive for commodity prices in the longer term), we believe that investment will pick up only if prices remain higher for longer. The required copper price for the 84 projects in our analysis has increased for the first time in more than four years, to US\$7,067/t from US\$5,324/t last year.

Demand: Concerns around recent events in EM/China overdone; we see growth ahead

- **EM concerns saw the first wave of outflows from copper...** The EM sell-off at the start of 2H18 was the first domino to fall. Synchronous growth had been the keyword at the start of the year, which saw commodities rally. However, as EM growth faltered, investors started taking a bearish view on the long-term growth prospects for these markets.
- **...China concerns were the second driver:** Soggy China data – FAI data for July/August, credit data and other activity data – was the second domino to fall. Given that China accounts for c.50% of total copper demand, this led to investors

taking an even more bearish view on the commodity. Data has continued to disappoint, but our economists believe it should start to pick up given the recent loosening by the policymakers.

- **EM sell-off and a stronger USD have been a headwind too:** A stronger dollar, implying a move to risk-off assets, has been another drag on copper prices.
- **We remain confident on demand growth despite recent weakness:** Despite the recent weakness, we remain confident on demand, with our commodities team forecasting demand growth of c.2% pa over the next three years. Our view is based on: (1) EM growth not being affected to the extent that the market appears to believe; we forecast EM copper demand growth of 3.5% over 2018-20; (2) China growth that is likely to remain strong – policymakers have started loosening by cutting onshore rates and by reducing restrictions on lending, which should be supportive of growth; and (3) DMs are expected to remain broadly flat – our commodities team forecasts growth of c.0.5% pa in DM copper demand over the next 3-4 years.
- **EVs likely to offer a material fillip to demand from the early 2020s:** China accounts for half of all global electric vehicle (EV) sales and continues to be the fastest-growing EV market. Even under relatively conservative assumptions, we estimate that copper consumption will increase 700ktpa from 2018 to 2025 on rising EV production, roughly half of which will come from China.

Equities: See pockets where valuation looks undemanding

- **Equities have had a choppy year...** Copper mining equities have had a volatile year after a very strong 2016/17. We believe the underperformance of equities vs. copper reflects an unwillingness by investors to pay high multiples given the lack of confidence in commodity prices.
- **Remain positive on copper prices albeit a more tempered view:** We remain positive on copper prices, albeit our commodities team now forecast a 12-month copper price of US\$6,885/t, down from their previous forecast of US\$8000/t by end-2019 given the recent hiccups in demand from EMs/China.
- **We expect capex and M&A to increase:** We believe capex is set to rise further, a trend already in evidence with miners across the size spectrum increasing both sustaining and growth capex. Another trend to watch is the rising tide of M&A, where we believe the companies that do not have attractive copper projects are likely to buy projects sitting with companies that do not have the resources to build them.
- **Favour equities that have strongly positioned projects:** Our preferred equities are those that have strong growth projects (i.e. that are well positioned in terms of jurisdiction and required copper price) and catalysts ahead. ***Reflecting these themes, our top picks with the highest exposure to copper remain GLEN, FM, FCX, MMG and Zijin while we downgrade Antofagasta to Sell.***

Exhibit 1: Summary financial metrics for global copper equities

Company	Share price Ccy	Last Close	Rating		12m PT		Return (%)	P/E			EV/EBITDA			Net debt/EBITDA			FCF Yield(%)			Dividend Yield(%)		
			New	Old	PT	Old		2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E
Diversifieds																						
BHP - LSE	GBP	1,692.00	Buy	Buy	1,950	2,000	15%	15.76x	15.48x	17.63x	5.45x	5.64x	6.04x	0.40x	0.33x	0.24x	8.1%	7.0%	6.7%	5.0%	4.3%	3.9%
BHP - ASX	AUD	35.41	Buy	Buy	40.0	42.0	13%	18.15x	17.82x	20.30x	5.92x	6.06x	6.42x	0.40x	0.33x	0.24x	7.4%	6.6%	6.3%	4.4%	3.8%	3.4%
Rio - LSE	GBP	3,917.50	Neutral	Neutral	4,000	4,000	2%	9.77x	10.54x	11.84x	5.49x	5.56x	5.97x	0.02x	0.19x	0.32x	6.3%	6.4%	4.8%	6.2%	5.6%	5.1%
Rio Tinto - ASX	AUD	79.95	Neutral	Neutral	82.0	84.0	3%	10.97x	11.83x	13.29x	6.04x	6.09x	6.52x	0.02x	0.19x	0.32x	5.7%	5.8%	4.3%	5.5%	5.0%	4.5%
Glencore	GBP	333.55	Buy	Buy	400	375	20%	8.20x	8.45x	10.79x	4.13x	3.87x	4.06x	0.49x	0.31x	0.07x	20.9%	16.3%	16.0%	5.3%	4.2%	5.6%
Anglo American	GBP	1,755.40	Buy*	Buy*	2,200	2,000	25%	10.12x	10.22x	12.90x	4.33x	3.86x	4.48x	0.42x	0.19x	0.21x	8.7%	9.4%	3.8%	4.4%	4.6%	3.7%
Norilsk Nickel	USD	17.20	Buy	Buy	24	25	40%	7.03x	6.75x	7.07x	5.94x	5.32x	5.79x	1.32x	1.14x	1.46x	13.6%	8.0%	7.9%	13.1%	14.4%	13.9%
Teck Resources Ltd.	USD	24.33	Neutral	Neutral	30	28	23%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Teck Resources Ltd.	CAD	31.28	Neutral	Neutral	38	37	21%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Copper																						
Antofagasta	GBP	879.40	Sell	Neutral	725	800	-18%	29.43x	14.30x	12.33x	7.58x	5.61x	5.22x	0.30x	0.16x	0.11x	1.9%	2.6%	3.2%	1.3%	2.6%	3.0%
Boliden	SEK	253.60	Neutral	Neutral	250	250	-1%	9.39x	9.89x	10.59x	4.71x	4.97x	5.02x	0.07x	0.04x	-0.07x	8.5%	6.7%	7.9%	6.4%	6.1%	5.6%
First Quantum Minerals	CAD	14.99	Buy	Buy	18.0	24.0	20%	22.38x	11.69x	7.98x	9.24x	6.44x	4.79x	3.57x	2.41x	1.49x	-3.9%	4.1%	15.7%	0.1%	0.1%	0.2%
Lundin Mining Corp.	SEK	47.34	Neutral	Neutral	50.0	51.0	6%	15.41x	9.19x	7.54x	4.97x	3.94x	3.04x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.0%	1.8%	1.7%	1.7%
Lundin Mining Corp.	CAD	6.67	Neutral	Neutral	7.3	7.5	9%	15.27x	9.10x	7.47x	4.91x	3.90x	3.01x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.1%	1.8%	1.8%	1.8%
KAZ Minerals Plc	GBP	553.60	Neutral	Neutral	575	450	4%	7.67x	9.45x	9.84x	4.66x	5.27x	5.41x	1.90x	2.20x	2.28x	-5.9%	-2.1%	-1.3%	0.3%	0.2%	0.2%
Aurubis AG	EUR	60.60	Neutral	Neutral	60.0	61.0	-1%	12.12x	14.98x	13.02x	5.38x	5.63x	5.01x	-0.53x	-0.96x	-1.04x	14.0%	8.9%	6.0%	3.4%	3.3%	3.6%
KGHM Polska Miedz SA	PLN	90.40	Sell	Sell	89	88	-2%	9.35x	8.15x	11.10x	4.60x	4.35x	4.34x	1.15x	1.01x	0.88x	8.5%	4.3%	5.7%	1.2%	1.0%	0.9%
Freeport-McMoran Inc.	USD	33.95	Buy	Buy	18.0	19.0	29%	8.79x	18.66x	14.81x	4.43x	7.20x	6.30x	0.93x	1.38x	0.86x	13.4%	4.3%	9.8%	1.4%	1.4%	1.4%
MMG Ltd	HKD	3.95	Buy	Buy	5.80	6.30	47%	14.75x	8.39x	7.44x	6.69x	5.41x	4.72x	3.67x	2.69x	2.06x	16.0%	18.4%	18.7%	0.0%	0.0%	0.0%
Jiangxi Copper	HKD	9.03	Neutral	Neutral	11.5	12.7	27%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Jiangxi Copper	CNY	14.47	Neutral	Neutral	17.10	18.80	18%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Zijin Mining	HKD	3.03	Buy	Buy	3.8	3.9	25%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
Zijin Mining	CNY	3.57	Buy	Buy	4.80	4.90	34%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
* Denotes member of our Pan Europe Conviction Investment List																						

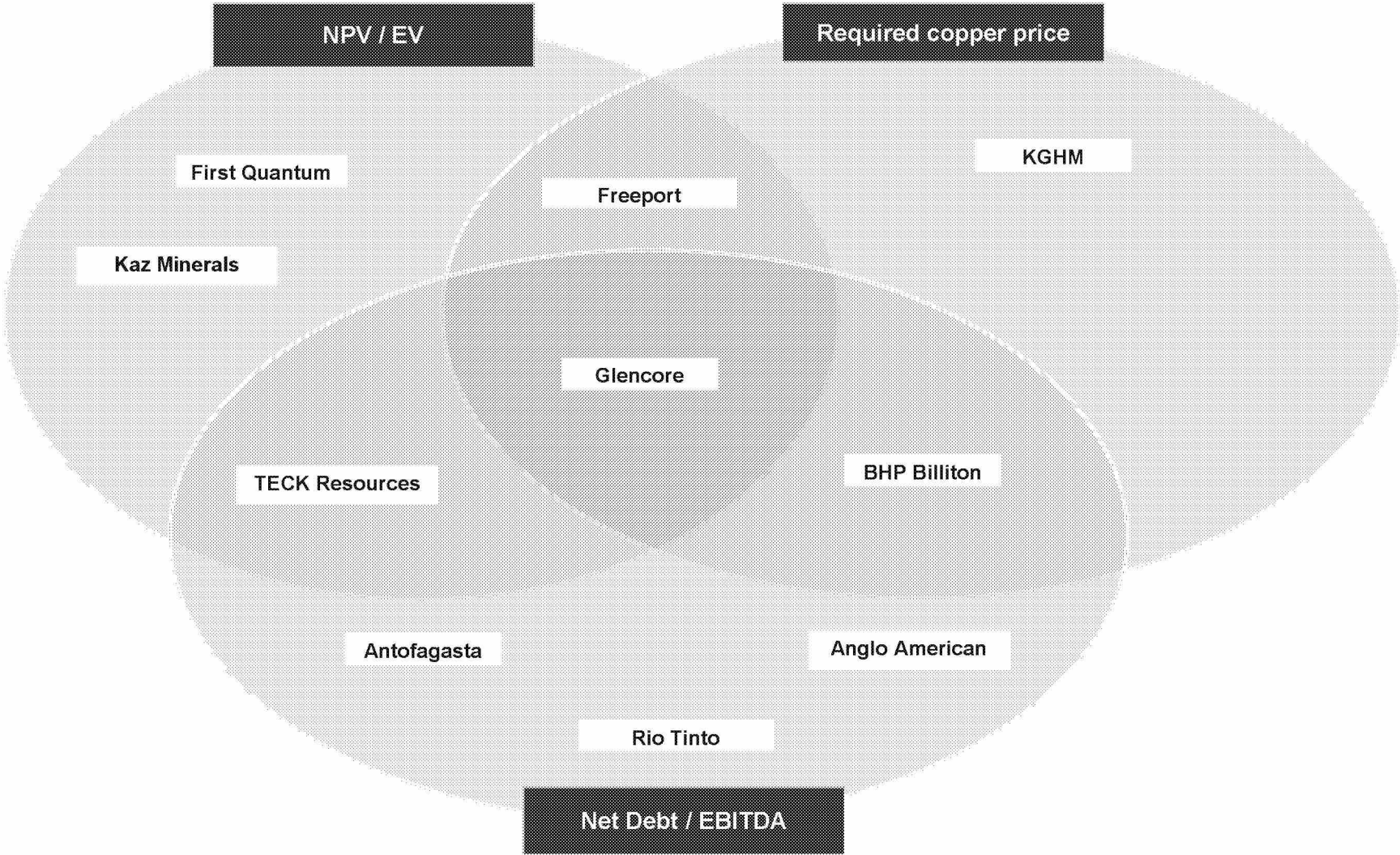
Source: Factset, Company data, Goldman Sachs Global Investment Research

Build or Buy remains the big decision: We have seen evidence of both

With the exception of Anglo American and Glencore, none of the big-cap mining companies in our coverage screen as having a portfolio of attractive copper assets (on our estimates). Given the attractiveness of copper for the miners (the big revenue pool that it represents) coupled with relatively strong balance sheets for most of the companies, we believe there is an important decision to be made: Build or Buy.

- **Build:** While the big miners – BHP, Rio, Glencore and Anglo American – have portfolios of growth options, these do not appear compelling, on our estimates. In our view, companies are likely to go ahead with brownfield expansions and projects where capex has partly been spent. Given that attractive greenfield options are increasingly scarce and expensive, we believe miners could look to acquire other attractive assets. BHP has recently opted to pursue expansion at Spence, and we believe that it is likely to go ahead with the Olympic Dam expansion too. Meanwhile, according to comments by RIO's CEO, the company is also looking to expand in copper.
- **Buy:** There are a number of projects owned by companies that do not have the resources to bring them to fruition. Given the historical precedents, we believe that miners with stronger balance sheets might look to acquire smaller companies; we have seen evidence of this with KAZ Minerals buying Baimskaya recently.

Exhibit 2: GLEN is best positioned, followed by Freeport, BHP and Teck

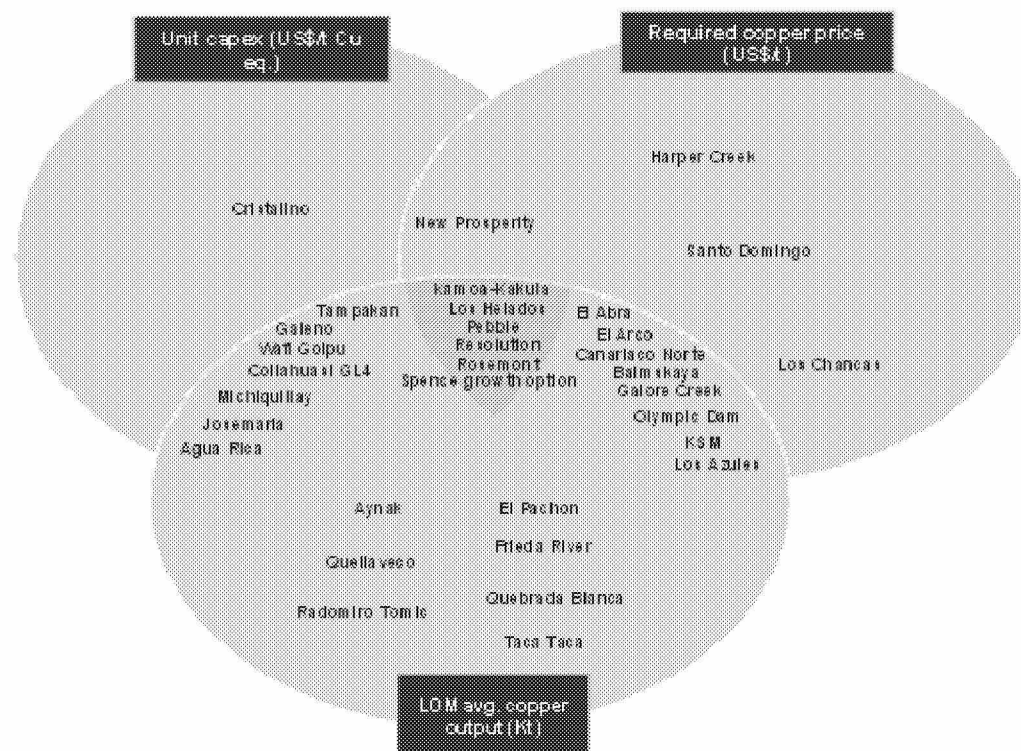


Source: Goldman Sachs Global Investment Research

Juniors continue to have the best undeveloped projects

To attempt to identify the most attractive projects, we look at three metrics: (1) capex intensity; (2) the required copper price to bring a project online; and (3) LOM average copper production. We look at projects for which the owners either do not appear to have the balance sheet strength to undertake such a big project and/or are solely exploration companies. *Note that one of the projects highlighted in our Top Copper Projects report - 2017, Baimskaya, was recently acquired by Kaz Minerals.*

Exhibit 3: Identifying the most attractive projects from our analysis



Source: Company data, Goldman Sachs Global Investment Research

Analysing what the market has overlooked over the past few years for copper

We discuss below what we believe the market has overlooked in the past few years that has led to significant downgrades to consensus price forecasts:

- **Supply:** In our view, the market has consistently overestimated the concentrate supply coming online. **Possible reason:** Project delivery being delayed vs. expectations.

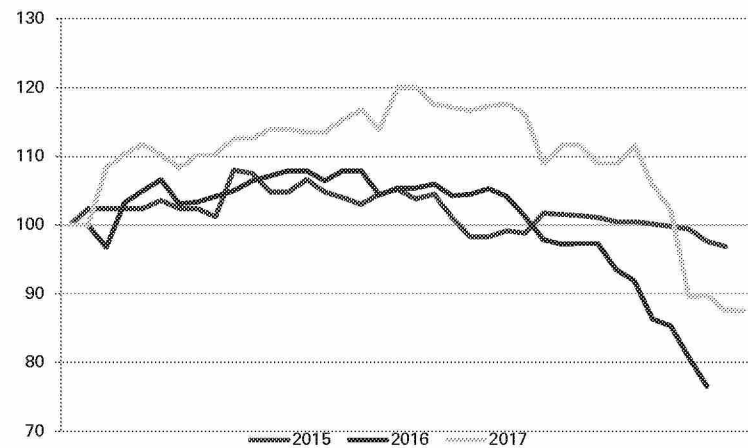
However, this has been offset by the following two factors:

- **Demand:** Demand has been one of the biggest downside surprises, with the market consistently downgrading forecasts. **Possible reason:** The slowdown in China in 2014. However, it is worth noting that demand forecasts more recently have been upgraded – mainly a function of stronger demand from China and RoW.
- **Disruptions:** Here, we believe the market has been overestimating the total number of disruptions. **Possible reason:** As copper prices fell, producers focused more closely on their operations, which resulted in fewer disruptions.

After shifting to a more bearish view on copper versus its historically bullish stance, the market appears to be turning more positive again, with consensus moving from a forecast surplus in 2018-20 to a deficit, implying price forecasts are likely to increase.

Exhibit 4: The average downgrade to consensus copper price forecasts for 2015-17 was 14% over a period of four years

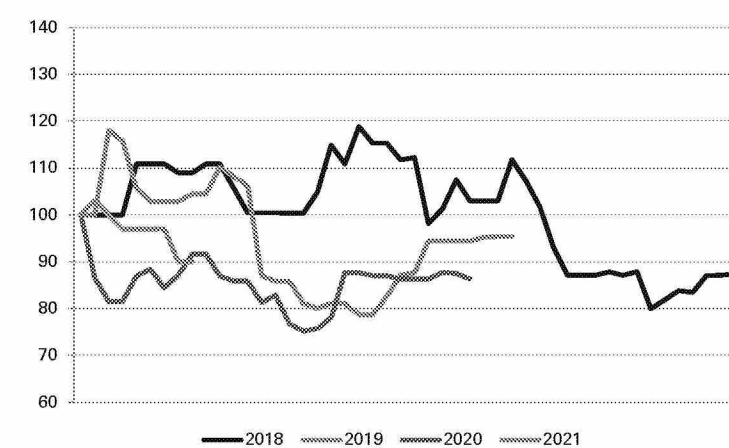
Commodity price forecasts for 2015/16/17 – rebased to 100 as of four years back



Source: Bloomberg

Exhibit 5: Consensus has downgraded its price expectations for copper for 2018-21 by an average 10% over the past few years

Commodity price forecasts for 2018/19/20 – rebased to 100 as of four years back



Source: Bloomberg

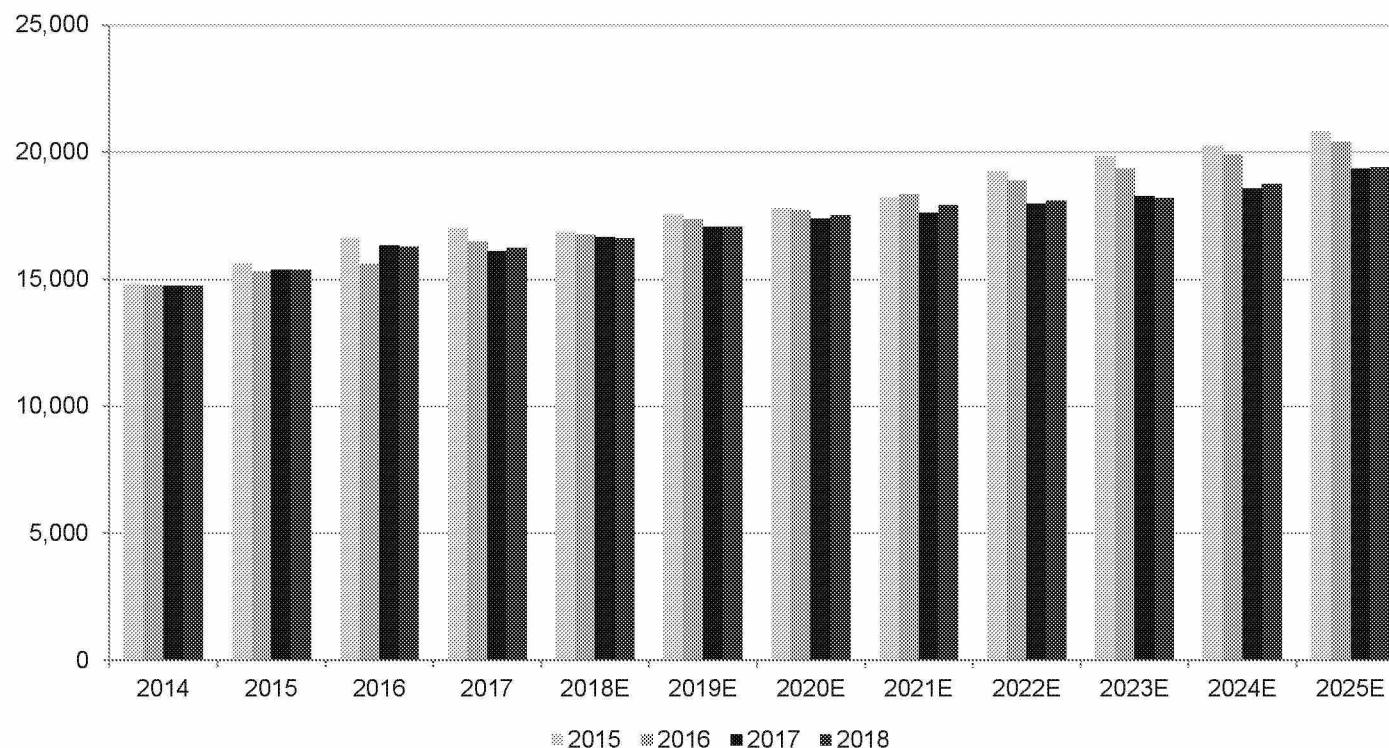
Supply: Market has been overly bullish on supply

As apparent from the exhibit below, the market has consistently been overly bullish on supply. It is difficult to determine the reasons for this, but they may include: (1) excessive optimism on growth projects, which rarely come online on time; and (2) a greater than expected grade decline.

How to read the chart: The bars represent Wood Mackenzie forecasts for copper concentrate production for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast.

Exhibit 6: Market has been overly bullish when forecasting supply

Supply forecasts for 2014-2025 (Kt)



Source: Wood Mackenzie

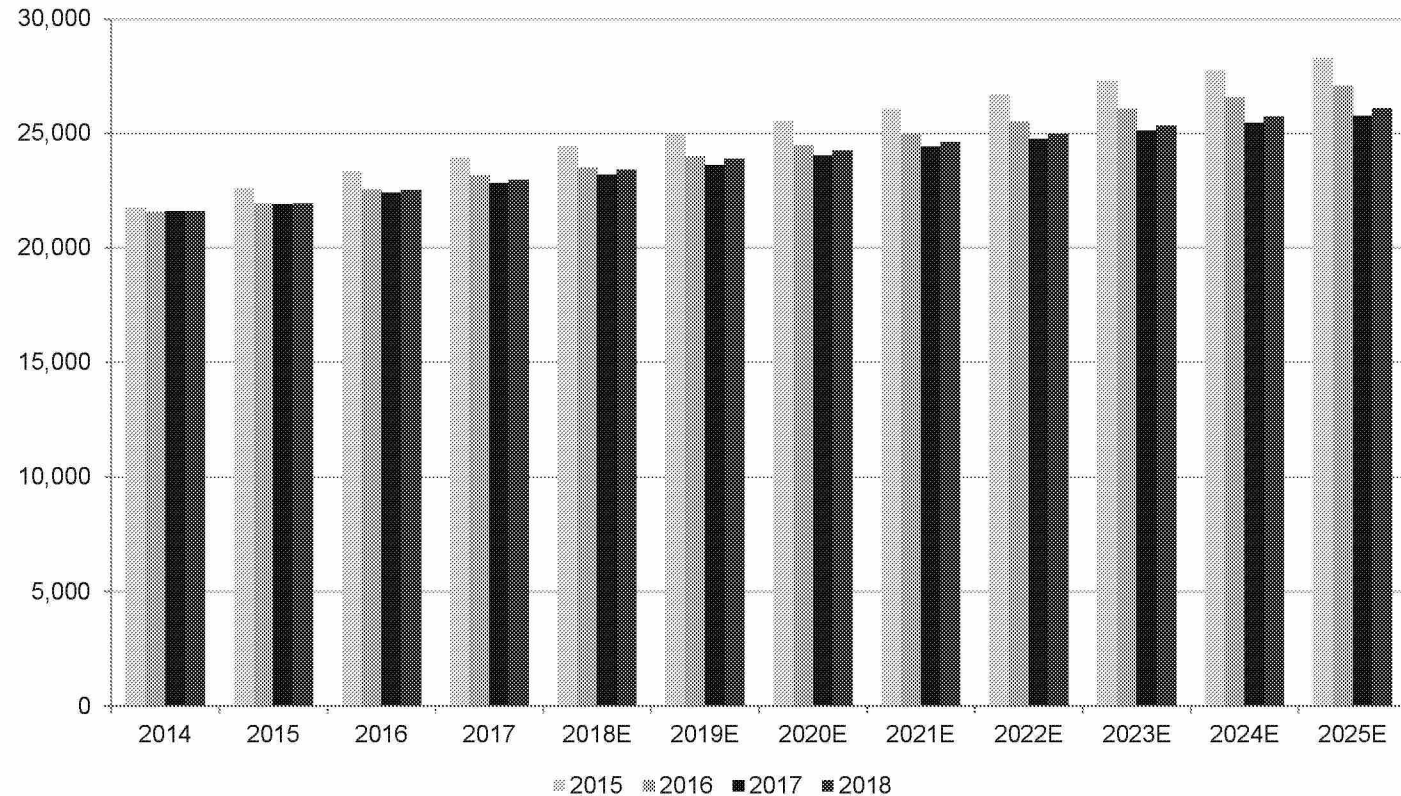
Demand: Market has been overly bullish on demand

As shown in the exhibit below, the market has also been overly bullish on demand too. We believe the main reason for this has been the significant slowdown in Chinese consumption: the growth rate of Chinese copper consumption slowed from an average of 12.2% in 2008-13 to 6.2% in 2013-17.

How to read the chart: The bars represent Wood Mackenzie forecasts for copper refined consumption for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast.

Exhibit 7: Market has been overly bullish when forecasting demand

Refined consumption forecasts for 2014-2025E (Kt)



Source: Wood Mackenzie

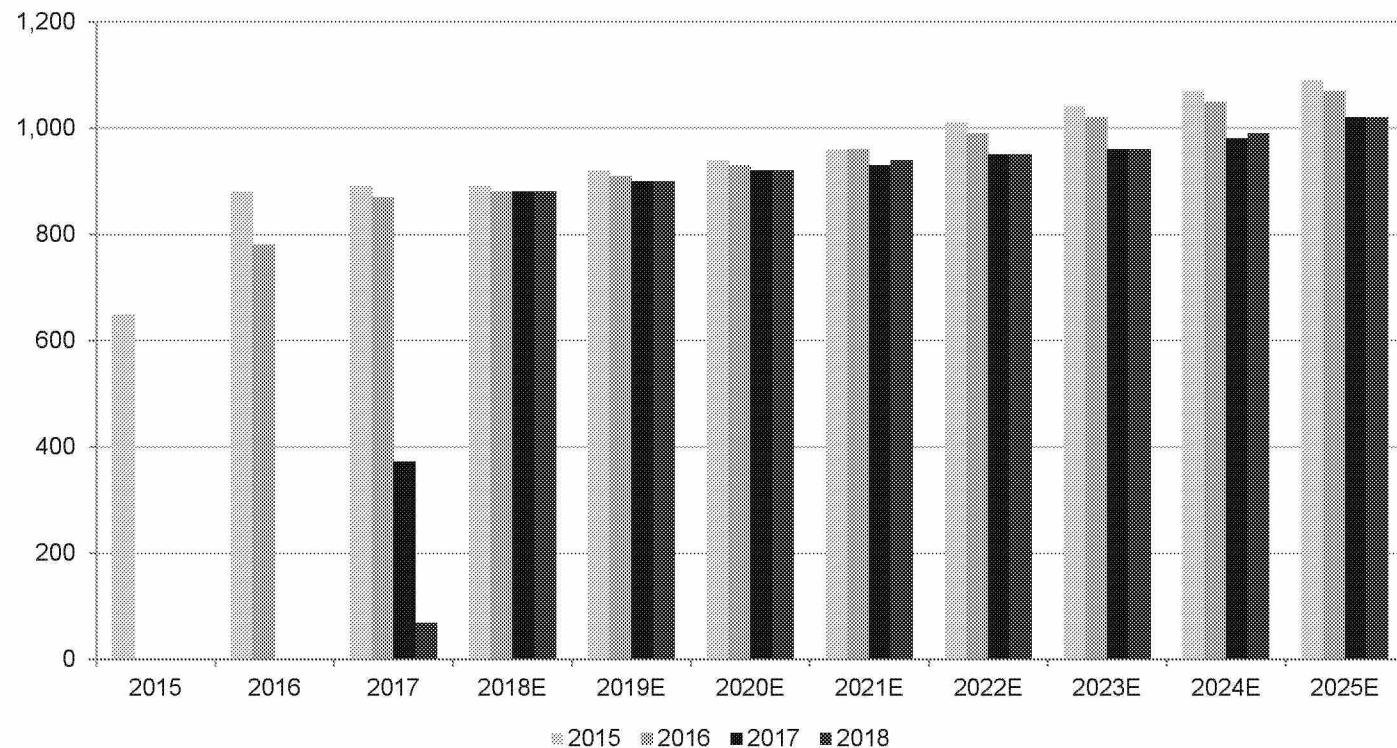
Disruption allowance: Market has overestimated the amount of disruption

In our view, the market has probably been building in a higher level of disruption allowance than actually materialised. This has led to the new disruption allowance being continually reduced. A potential reason for the reduced level of disruption is that as copper prices fell, miners started focusing more closely on their operations and demands for pay rises by unions became less significant, which resulted in lower disruptions.

How to read the chart: The bars represent Wood Mackenzie forecasts for disruption allowance for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast

Exhibit 8: Disruption allowance has steadily declined

Disruption allowance forecasts for 2015-2025E (Kt)



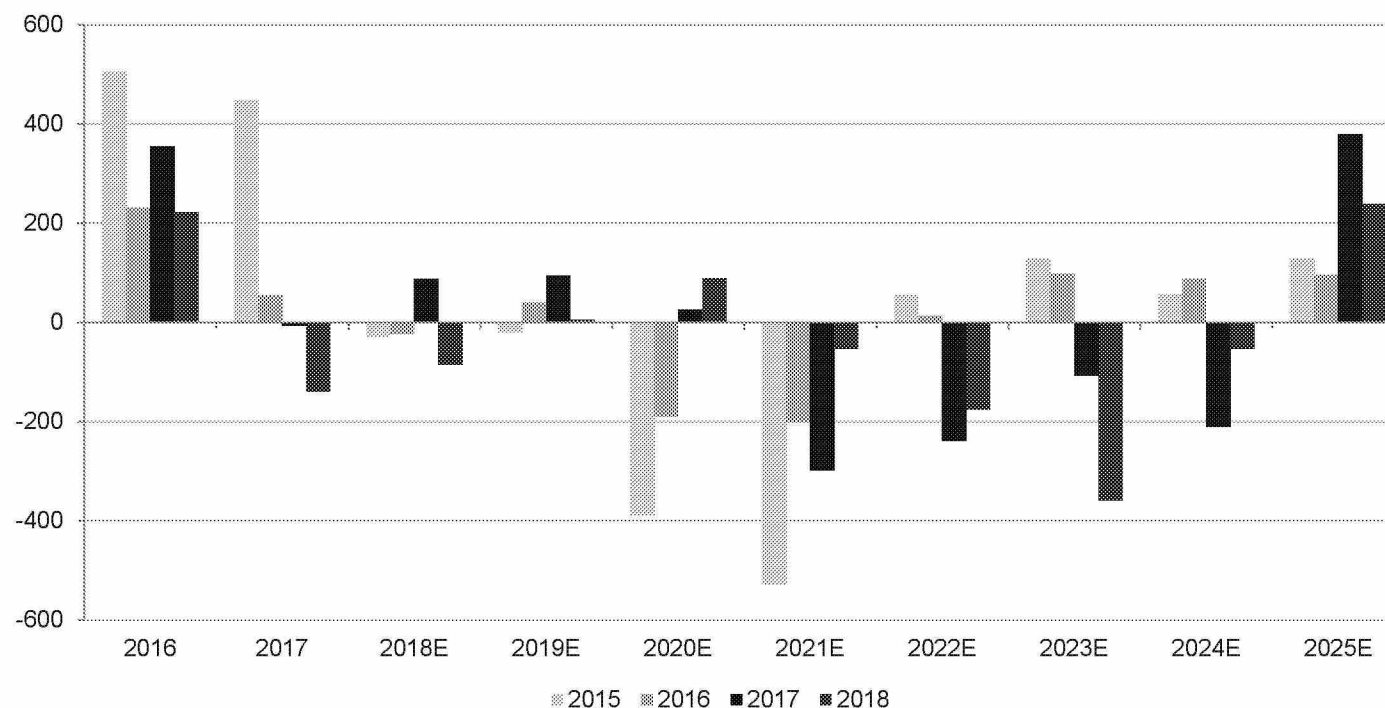
Source: Wood Mackenzie

Forecasts have narrowed and in some cases turned to surpluses

While supply forecasts have been bullish, the overly optimistic demand forecasts and disruption allowances have seen many deficit forecasts (e.g. 2018, 2019 and 2020) turn into surpluses (large and small), and in most cases large deficits turn into smaller ones (e.g. 2021). Most interesting, in our view, are the 2018/19 forecasts – in 2017, the forecast was for a surplus, and a fairly significant one. However, that has changed more recently as the market has moved into a deficit for 2018 and a much smaller surplus for 2019.

How to read the chart: The bars represent Wood Mackenzie forecasts for surpluses/deficits for the editions 2015, 2016 and 2017; for example, the four bars in the cluster 2018E represent what Wood Mackenzie was forecasting for 2018 in 2015, 2016, 2017 and the current forecast.

Exhibit 9: Surplus/deficit forecasts for copper, 2014-18 (Kt)



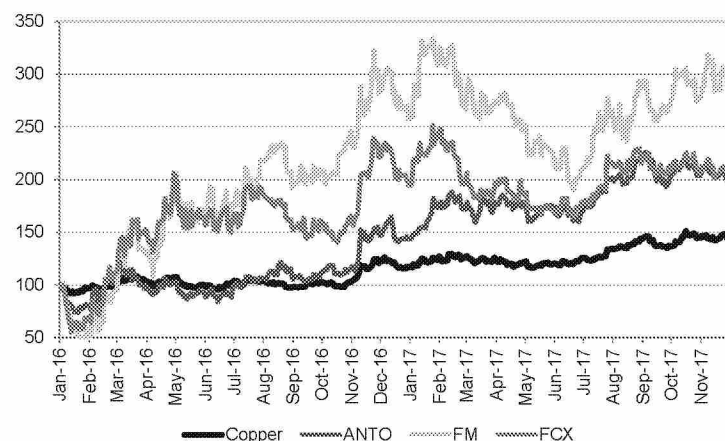
Source: Wood Mackenzie

Copper equities have traded poorly this year on reduced confidence in prices

2016/17 were strong years for copper and copper equities. Equities outperformed the underlying commodity (copper in this case) by multiples of 2-3x, mainly as investors grew more confident in the outlook for copper prices, underpinned by confidence in demand, and an increasingly consensus view that supply growth was disappointing and there were multiple risks to supply in the form of disruptions ahead.

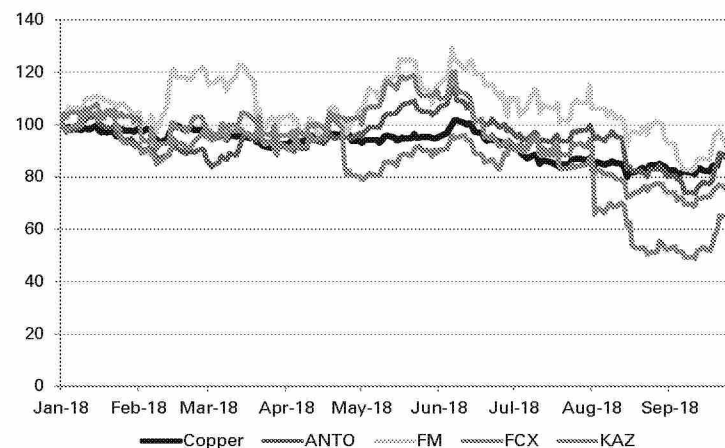
This year, however, has been very choppy for the equities. While the start of the year was strong, the equities have more than given up their gains as investors have become notably cautious on the future of copper, mainly owing to concerns over demand from EMs and China. As a result of these concerns, despite strong fundamentals and copper prices being relatively unchanged YTD, equities have traded poorly and most of them are down.

Exhibit 10: 2016/17 were very good years for copper/copper equities...



Source: Datastream

Exhibit 11: ...however, this year has been very choppy for the equities



Source: Datastream

Prefer equities with attractive projects, catalysts ahead

Our framework for selecting copper equities is simple – we prefer equities that have attractive projects (i.e. have a lower required copper price to bring the projects online, and are in stable jurisdictions) and have moved ahead with those projects. In addition, we also favour those that also have some catalysts in the near future.

Our key actionable ratings

- **Buy BHP:** (1) Strong returns; (2) Attractive commodity mix; (3) Strong copper portfolio.
- **Buy Anglo (on CL):** (1) Quellaveco is a Tier 1 project; (2) Attractive commodity mix; and (3) Valuation undemanding.
- **Buy GLEN:** (1) Attractive commodity mix; (2) Strong FCF generation/potential for returns ramp-up; (3) Outcome of DoJ investigation a risk.
- **Buy Norlisk:** (1) FCF inflection; (2) Delevering ahead; (3) Consensus (Bloomberg) mispricing earnings, in our view.
- **Sell Antofagasta:** (1) Valuation high; (2) FCF/returns tier 4/3 vs. peers; (3) Growth options look unconvincing.
- **Buy First Quantum:** (1) Cobre to come online next year; (2) Strong FCF generation/delevering; and (3) Valuation undemanding.
- **Buy FCX:** (1) Strong copper exposure; (2) Grasberg resolution a positive; (3) Strong FCF generation.
- **Sell KGHM:** (1) Low cash generation; (2) Valuation looks demanding.
- **Buy MMG Ltd:** (1) High leverage to copper prices; (2) We see net gearing falling; (3) Strong FCF generation.
- **Buy Zijin Mining:** (1) Strong copper growth ahead; (2) Active in M&A; (3) Strong FCF generation.

Exhibit 12: Summary key financial metrics

Company	Share price Ccy	Last Close	Rating		12m PT		Return (%)	P/E			EV/EBITDA			Net debt/EBITDA			FCF Yield(%)			Dividend Yield(%)		
			New	Old	PT	Old		2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E	2018E	2019E	2020E
Diversifieds																						
BHP - LSE	GBP	1,692.00	Buy	Buy	1,950	2,000	15%	15.76x	15.48x	17.63x	5.45x	5.64x	6.04x	0.40x	0.33x	0.24x	8.1%	7.0%	6.7%	5.0%	4.3%	3.9%
BHP - ASX	AUD	36.41	Buy	Buy	40.0	42.0	13%	18.15x	17.82x	20.30x	5.92x	6.06x	6.42x	0.40x	0.33x	0.24x	7.4%	6.6%	6.3%	4.4%	3.8%	3.4%
Rio - LSE	GBP	3,917.50	Neutral	Neutral	4,000	4,000	2%	9.77x	10.54x	11.84x	5.49x	5.56x	5.97x	0.02x	0.19x	0.32x	6.3%	6.4%	4.8%	6.2%	5.6%	5.1%
Rio Tinto - ASX	AUD	79.95	Neutral	Neutral	82.0	84.0	3%	10.97x	11.83x	13.29x	6.04x	6.09x	6.52x	0.02x	0.19x	0.32x	5.7%	5.8%	4.3%	5.5%	5.0%	4.5%
Glencore	GBP	333.55	Buy	Buy	400	375	20%	8.20x	8.45x	10.79x	4.13x	3.87x	4.06x	0.49x	0.31x	0.07x	20.9%	16.3%	16.0%	5.3%	4.2%	5.6%
Anglo American	GBP	1,755.40	Buy*	Buy*	2,200	2,000	25%	10.12x	10.22x	12.90x	4.33x	3.86x	4.48x	0.42x	0.19x	0.21x	8.7%	9.4%	3.8%	4.4%	4.6%	3.7%
Norilsk Nickel	USD	17.20	Buy	Buy	24	25	40%	7.03x	6.75x	7.07x	5.94x	5.32x	5.79x	1.32x	1.14x	1.46x	13.6%	8.0%	7.9%	13.1%	14.4%	13.9%
Teck Resources Ltd.	USD	24.33	Neutral	Neutral	30	28	23%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Teck Resources Ltd.	CAD	31.28	Neutral	Neutral	38	37	21%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Copper																						
Antofagasta	GBP	879.40	Sell	Neutral	725	800	-18%	29.43x	14.30x	12.33x	7.58x	5.61x	5.22x	0.30x	0.16x	0.11x	1.9%	2.5%	3.2%	1.3%	2.6%	3.0%
Boliden	SEK	253.60	Neutral	Neutral	250	250	-1%	9.39x	9.89x	10.59x	4.71x	4.97x	5.02x	0.07x	0.04x	-0.07x	8.5%	6.7%	7.9%	6.4%	6.1%	5.6%
First Quantum Minerals	CAD	14.99	Buy	Buy	18.0	24.0	20%	22.38x	11.69x	7.98x	9.24x	6.44x	4.79x	3.57x	2.41x	1.49x	-3.9%	4.1%	15.7%	0.1%	0.1%	0.2%
Lundin Mining Corp.	SEK	47.34	Neutral	Neutral	50.0	51.0	6%	15.41x	9.19x	7.54x	4.97x	3.94x	3.04x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.0%	1.8%	1.7%	1.7%
Lundin Mining Corp.	CAD	6.67	Neutral	Neutral	7.3	7.5	9%	15.27x	9.10x	7.47x	4.91x	3.90x	3.01x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.1%	1.8%	1.8%	1.8%
KAZ Minerals Plc	GBP	553.60	Neutral	Neutral	575	450	4%	7.67x	9.45x	9.84x	4.66x	5.27x	5.41x	1.90x	2.20x	2.28x	-5.9%	-2.1%	-1.3%	0.3%	0.2%	0.2%
Aurubis AG	EUR	60.60	Neutral	Neutral	60.0	61.0	-1%	12.12x	14.98x	13.02x	5.36x	5.63x	5.01x	-0.53x	-0.96x	-1.04x	14.0%	8.9%	6.0%	3.4%	3.3%	3.5%
KGHM Polska Miedz SA	PLN	90.40	Sell	Sell	89	88	-2%	9.35x	8.15x	11.10x	4.60x	4.35x	4.34x	1.15x	1.01x	0.88x	8.5%	4.3%	5.7%	1.2%	1.0%	0.9%
Freeport-McMoran Inc.	USD	33.95	Buy	Buy	18.0	19.0	29%	8.79x	18.66x	14.81x	4.43x	7.20x	6.30x	0.93x	1.38x	0.86x	13.4%	4.3%	9.8%	1.4%	1.4%	1.4%
MMG Ltd	HKD	3.95	Buy	Buy	5.80	6.30	47%	14.75x	8.39x	7.44x	6.69x	5.41x	4.72x	3.67x	2.69x	2.06x	16.0%	18.4%	18.7%	0.0%	0.0%	0.0%
Jiangxi Copper	HKD	9.03	Neutral	Neutral	11.5	12.7	27%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Jiangxi Copper	CNY	14.47	Neutral	Neutral	17.10	18.80	18%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Zijin Mining	HKD	3.03	Buy	Buy	3.8	3.9	25%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
Zijin Mining	CNY	3.57	Buy	Buy	4.80	4.90	34%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
* Denotes member of our Pan Europe Conviction Investment List																						

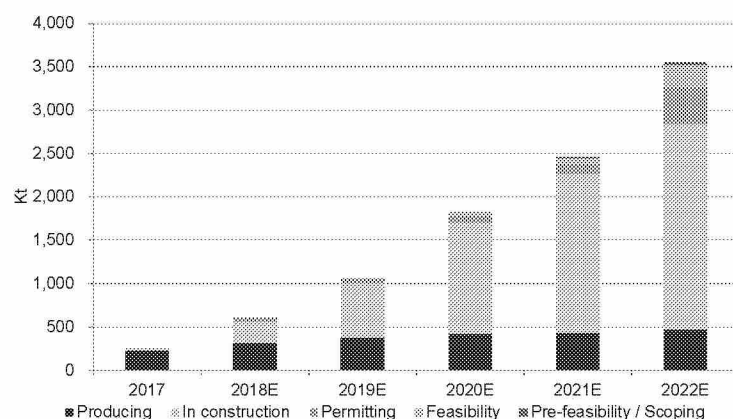
Source: Factset, Company data, Goldman Sachs Global Investment Research

Supply: Pace of supply additions has slowed dramatically; country risks have increased

One big change from the 2017 edition of our report has been the pace of supply additions that we expect to come online in the next few years. Last year, we had forecast c.2.4 mn tonnes of new supply to come online between 2017 and 2020. Based on our latest models, we believe that a total of c.1.6 mn tonnes of new supply is set to come online between 2018 and 2020. While this partly reflects our removal of some projects that have come online/reached full production, the biggest reason for the decline in production adds is that the companies have continued to either delay or not move ahead with the growth projects as we had expected last year.

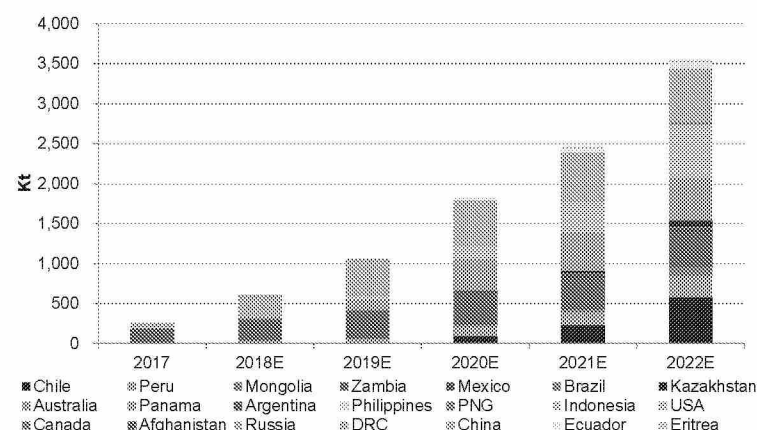
More than 60% of the production uplift according to our model is set to come from two countries – Zambia and DRC – where there has recently been a significant escalation in risk (a US\$8 bn tax bill imposed on First Quantum in Zambia and material tension regarding new royalties in DRC). We do not expect the risk to subside in the near future.

Exhibit 13: On an unrisks basis, we expect a cumulative 1.6 mn tonnes to be added to 2020
New copper production (Kt)



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 14: More production is coming from risky jurisdictions
New copper production by country (kt)

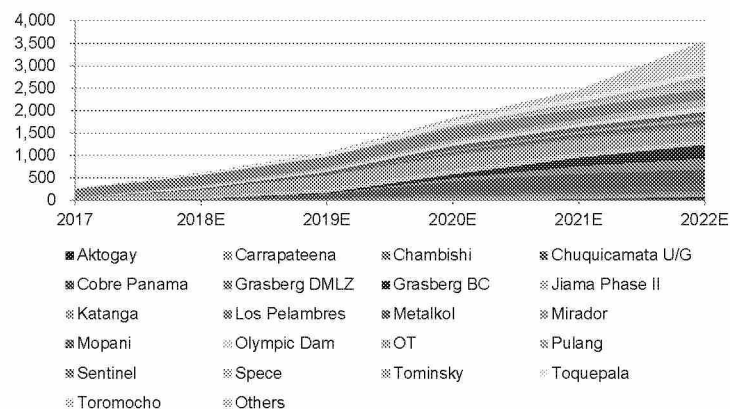


Source: Company data, Goldman Sachs Global Investment Research

Few mines/companies contributing the most to supply increase; raises risk of disruptions

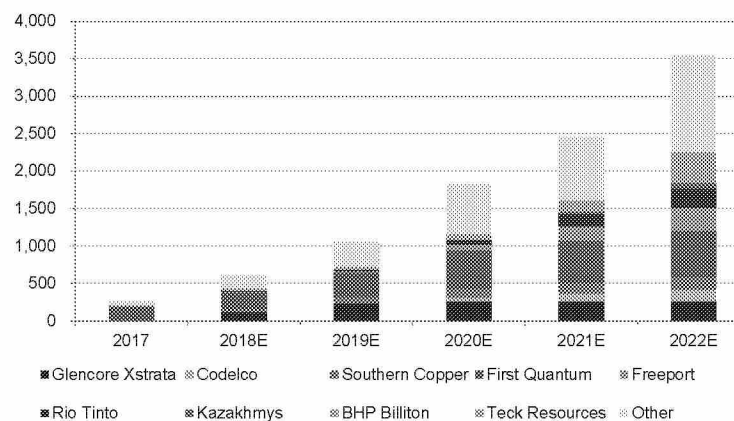
Another risk to a production uplift in the near-to-medium term is mine- and company-specific factors. Just three mines in our analysis (Sentinel, Cobre Panama and Katanga) contribute > 50% of the production increase we expect in the near term. Among these, we believe the majority of the risk relates to Cobre Panama and Katanga: Cobre Panama because it is a new mine that is scheduled to come online next year (new copper mines seldom reach their ramp-up targets) and Katanga given the risks associated with the jurisdiction (DRC). With regard to company-specific factors, the majority of the expected production increase comes from just 2-3 companies, with First Quantum and Glencore being the most important. While we do not foresee any company-specific factors affecting either of them, we highlight that risks do exist given the jurisdictions in which these companies operate.

Exhibit 15: c.50% of production increase to come from three mines in 2018/19E
Kt



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 16: c. 40% of the production increase to come from 2-3 companies over the next two years
Kt



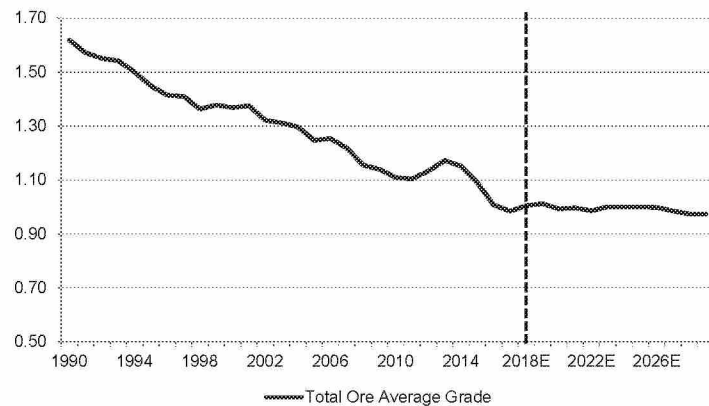
Source: Company data, Goldman Sachs Global Investment Research

Grade decline presents risks to forecasts; risk of disruption to rise as mines move underground

One change in our view since our last publication relates to grade decline. Last year, our view was that the grade decline we observed was likely a function of the grades that miners were choosing to mine in response to lower prices, rather than underlying mine degradation. However, given that the decline has persisted despite the improvement in prices, we believe it reflects the natural degradation of the resource, which has positive implications for copper prices. While Wood Mackenzie forecasts grade to remain constant, we see downside risk to these estimates.

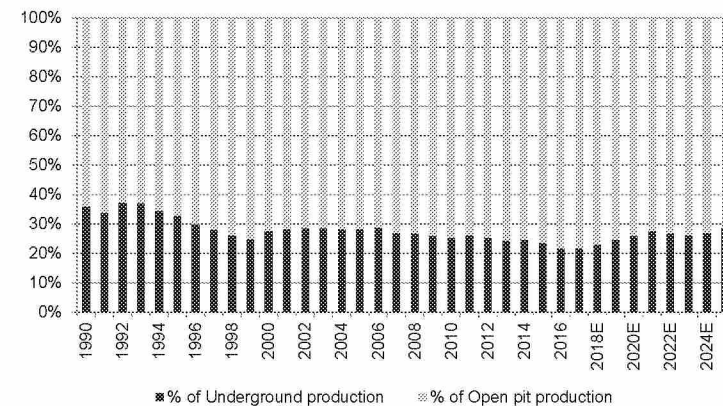
Another trend to keep in mind is the increasing number of mines moving underground. Wood Mackenzie forecasts the total proportion of underground operations to increase from c.22% as of 2017 to >30% by 2027. Underground mines by nature are riskier and are prone to disruptions, which could be a potential source of upside for copper prices in the longer term.

Exhibit 17: Grade has continued to decline over the last 3-4 years; this trend is likely to continue



Source: Wood Mackenzie

Exhibit 18: In addition, as the % of underground mines increases, the risk of disruptions is higher



Source: Wood Mackenzie

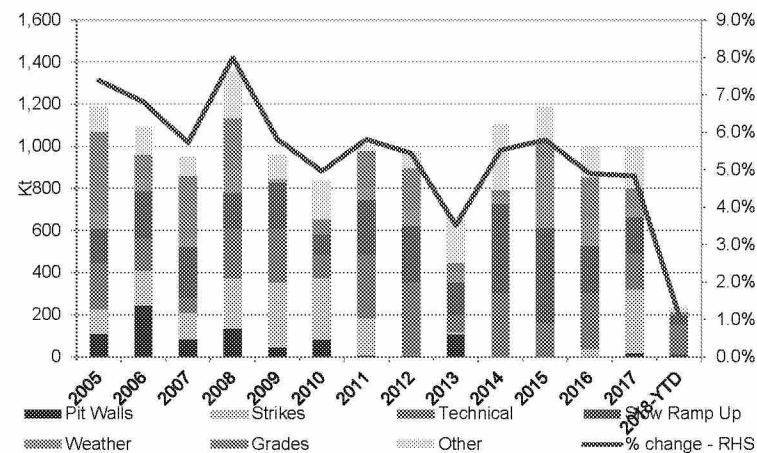
Disruptions: YTD disruptions have been running low on successful wage talks, strong productivity

YTD disruptions have been running at a historically low rate, primarily a function of almost no wage-related disputes. We had believed that given the number of wage negotiations this year, there would likely be a meaningful number of disruptions, which have not materialised. The low level of labour-related disruptions is atypical for the current level of margins. To a large extent, the strikes have been avoided because the companies have been more accommodative to workers' demands than observed historically. We find that during past strikes, the resulting pay deals were normally much closer to companies' initial offers than unions' proposals (see [Metals Express: Copper labour talks - what does history say?](#)).

In our view, one reason why companies have been keen to avoid strikes this year is the elevated level of uncertainty regarding the future demand outlook and direction of copper prices. In particular, China's high copper demand per capita relative to its income leads to concerns that the country has brought forward a large amount of its future copper consumption, creating significant downside risks to forward demand growth. Such concerns also contribute to the still depressed level of mining company valuations, in our view. Lastly, the push for higher productivity has seen mines running more smoothly than we would have anticipated at the start of the year.

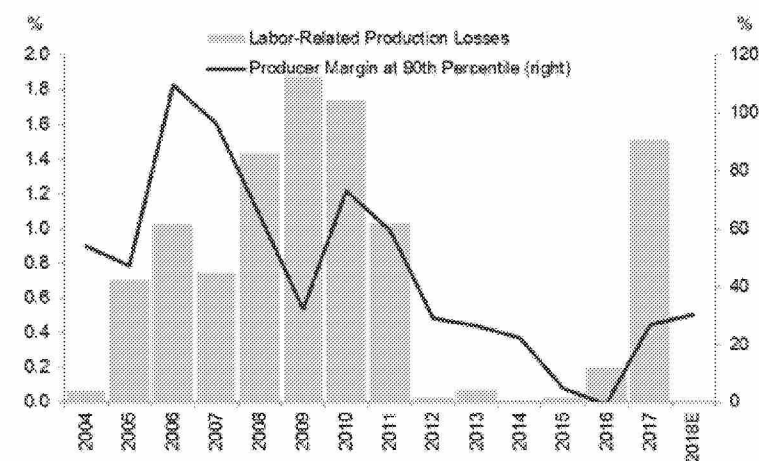
Exhibit 19: YTD copper disruptions have been at a historic low

Copper supply disruptions 2005-18 ytd



Source: Wood Mackenzie

Exhibit 20: Labour disruptions surprised to the downside in 2018



Source: Wood Mackenzie, Goldman Sachs Global Investment Research

Rising ESG issues having an impact on copper production

While YTD disruptions are running at an all-time low, we highlight that there have been a number of issues building. These reflect factors such as more stringent environment/climate-related policies by governments and local/federal authorities and protests by local communities leading to mining stoppages and/or the cancellation of mining concessions.

- **Las Bambas:** Since the mine reached full production in 2016, it has faced a number of problems. The most recent source of tension relates to allegations by populations living near the highways where the trucks carry copper py that the trucks are encroaching on their land and having an adverse impact on the local environment. This issue has persisted and presents a material risk to the copper supply; Las Bambas produces c.300ktpa of copper each year.
- **Pebble:** Continued opposition by local communities in Alaska has led to the US government reversing its stance on the project. When the Trump government took office in 2016, the EPA had said that it was working towards approving the copper project in Alaska. First Quantum had also been interested in the project at one point. However, the project has been put on hold as of now. While we include the project in our analysis, we ascribe a low probability to it coming online.
- **Grasberg:** While the ownership issues at Grasberg are heading towards a resolution, with the Indonesian government set to own c.51 % of the mine by early 2019, one remaining issue is the management of tailings that are disposed of into the sea via the local river system. The environmental ministry had said earlier this year that the company needs to reduce the amount of tailings from 90% to 50%.

Overall, we believe that the focus by governments on environmental standards, and opposition to mining activity from populations living in surrounding areas, are likely to increase. As an example, the government of Chile recently announced that it is seeking to put restrictions on new water extraction rights from lithium-rich Salar de Atacama salt flats. The region is home to lithium miners such as Albemarle and SQM. Regulators have banned the issuance of new permits to extract water from south of Salar's watershed – a key water supply to the Escondida and Zaldívar mines. The proposal by BHP to cut water use has been deemed insufficient by the government. While the impact is not quantifiable as of now, we believe that governments (across the world) are likely to focus increasingly on environmental protection, which will increase the costs and complexity involved in the extraction of copper.

Codelco, GLEN and Freeport: Three big determiners of copper supply

Codelco, Glencore and Freeport together account for c.25% of total copper production; this, as well as their significant pipeline of growth projects, makes them important for the copper market.

Codelco – multiple growth assets but capital a constraint

Codelco is the world's largest copper producer (c.10% of total copper produced in 2017). The company has multiple growth assets, Chuquicamata underground being the one that will deliver production near term; other assets are: Radomiro Tomic (Sulphides II) and Andina and El Teniente. These projects are still under study and are not expected to start production before 2023/24, as the company is currently prioritising spending on Chuquicamata underground given capital constraints and the significant debt load.

Despite declining copper grades, Codelco was able to raise year-on-year production in 2017, mainly due to strong performance from Chuquicamata and Andina. The company is now budgeting \$21 bn through 2022 to maintain output levels after years of underinvestment. In June 2018, the Chilean government unveiled \$1 bn of funding through February to support Codelco's growth projects and halt the decline in production levels. We view this as supportive of Codelco's plan to grow its copper production profile.

Chuquicamata: The mine is moving from an open pit mine to a modern underground operation with more mechanised processes in order to cut costs and raise production rates. This has caused concern among workers at the mine, who went on strike in July to protest against the underground plan. According to the latest news flow, the underground portion of the mine should start to produce copper from 3Q19; however, we take a more cautious view and assume first production in 2020.

Andina Phase II: The second phase of the project is to ramp up daily processing capacity by 150kt to 244kt. However, at the beginning of 2018, Codelco announced that it would alter the Andina mine plan as a result of glaciers. This will take approximately three years to carry out and is reliant on the improvement of the environmental impact study. We expect the project to be delayed, with construction set to start in 2019 and first production to take place in 2024.

El Teniente: The mine is the world's largest underground copper mine. In early 2018, it was facing medium-term copper production challenges owing to declining grades and the depletion of some of the current exploration areas. To address this, the company is working on the development of the NNM (Nuevo Nivel Mina), where we expect first production in 2023; revised capex of \$5 bn (from \$3 bn) was announced in July. The project should prolong production at El Teniente for an additional 50 years, allowing the division to maintain copper production of around 400ktpa.

Radomiro Tomic: The mine is currently undergoing phase 2 of development, which will include two dedicated 100kt/d concentrators. The project is in the feasibility stage, with Codelco already receiving EIA approvals. The next stage of the project is approval by the Codeclo board and Cochilo. Given the lack of news flow on the project and the prioritisation of the Chuquicamata mine, we assume the mine comes online in 2024.

Exhibit 21: Codelco has a number of growth projects but is focused on Chuquicamata for now

Codelco growth projects

Codelco				
Key Metrics	Chuquicamata	Andina Phase II	El Teniente	Radomiro Tomic
Project status	Construction	Feasibility	Construction	Pre-feasibility
Start Year	2020	2024	2023	2024
Capex (\$ mn)	4,200	7,600	5,100	5,900
Average Production (ktpa)	329	343	407	343
Life of Mine	29	19	28+	27+
IRR (%)	13%	9%	13%	15%
NPV @ 8% (incl. sunk) (US\$ mn)	4,203	319	3,497	3,654
NPV @ 8% (2017+) (US\$ mn)	8745	319	409	4306
Reqd Copper Price (\$/t)	7,482	8,796	7,460	6,553
C1 cash cost(\$/t)	3,181	3,161	3,627	3,239

Source: Company data, Goldman Sachs Global Investment Research

Freeport/Grasberg agreement after years of negotiations; production ramp-up still a concern

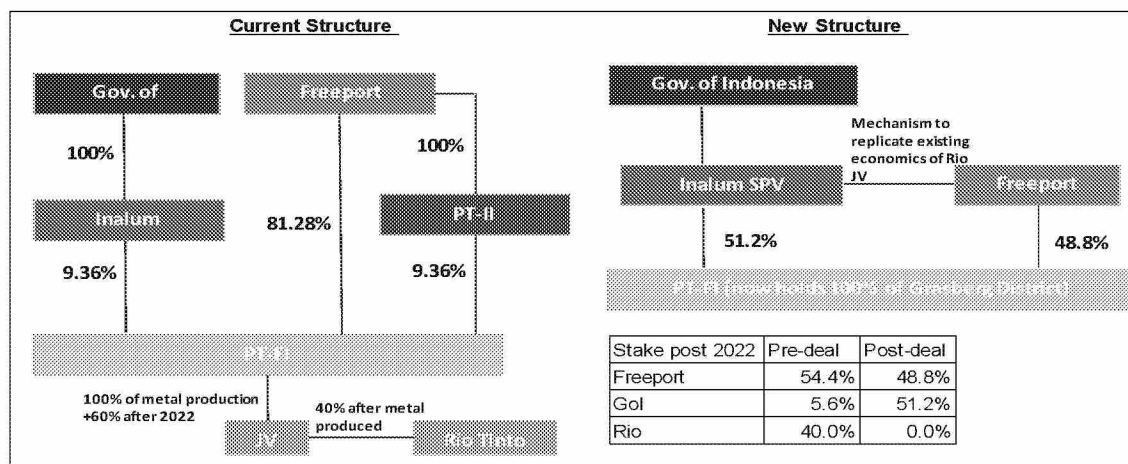
After several years of negotiations between Freeport and Indonesia, a binding agreement with PT Indonesia Asahan Aluminium was signed on September 27, 2018 regarding the divestment of a stake in Freeport's Grasberg mine. The overall deal size announced is the same as that highlighted in July's Heads of Agreement (\$3.85 bn total proceeds, with \$3.5 bn of proceeds for Rio's stake and \$350 mn for Freeport's stake), but additional clarity was offered on the timing of the transfer of the stake, the path to resolving environmental claims and agreements on operating rights going forward.

Historically, the negotiations were centred on the ownership of the Indonesian Grasberg mine. The Indonesian government wanted Freeport to sell a part of the Grasberg stake to local investors to meet requirements for government ownership of at least 51% for the asset. This is part of a broader push by Jakarta to give Indonesians greater control of the country's natural resources. Production from the open pit mine is expected to end in 2018-19, with the mine transitioning to a fully underground operation by 2020.

Current structure

Under the current structure, Freeport owns a 90.64% stake in Grasberg through an 81.28% interest in PT-FI and an additional 9.36%. As part of this arrangement, Rio Tinto has also received a small, variable stream of the revenues depending on certain production thresholds, and after mining through a certain region of the Grasberg deposit was complete (planned for 2022-23), Rio Tinto's stream would increase to a full 40%, with the jointly owned PT-FI receiving the remainder. Effective ownership of Grasberg after this point would be Rio Tinto 40%, Freeport 54.4% (60% x 90.64%), and Government of Indonesia 5.6% (60% x 9.36%).

Exhibit 22: Grasberg: New structure vs. old structure



Source: Company data, Goldman Sachs Global Investment Research

New structure

Under the proposed new structure, Rio Tinto's JV interest would be converted to a share of PT-F that would transfer to Inalum (for \$3.5 bn), with Freeport then divesting a 9.36% stake (for \$350 mn) in PT-FI to Inalum. As shown above, effective ownership of Grasberg would then be split between Freeport, with a 48.8% stake in PT-FI $([90.64\% - 9.36\%] \times 60\%)$, and Inalum owning the balance of 51.2% – giving the government a stake of over 51%, which has been its long-term objective. Freeport would remain the operator of the mine despite Indonesia owning a majority of the equity and there will be no requirement for Freeport to divest any additional interest in the mine.

Under the terms of the new agreement, Freeport's cash flows would remain essentially the same as under the current structure, as the company would continue to receive the vast majority of cash flows through the period until which Rio Tinto's 40% interest would have kicked in. The only difference would be due to the immediate dilution of 9.36% ownership to Inalum for \$350 mn, leaving FCX with an effective 81.28% of medium-term cash flows instead of 90.36%. Inalum will also fund the capital required for underground development that would have been contributed by Rio Tinto.

As part of this new structure, Freeport will construct a new \$3 bn copper smelter in Indonesia within five years of the completion of the transaction. The capital is likely to come from project financing, with Freeport and Inalum contributing only limited equity if necessary.

Exhibit 23: Freeport has two projects at Grasberg that are being ramped up
Freeport growth projects

Freeport		
Key Metrics	GrasbergDMLZ	Grasberg BC
Project Status	Construction	Construction
Start Year	2015	2016
Capex (\$ mn)	3,200	6,700
Average Production (ktpa)	125	246
Life of Mine	21	24
IRR (%)	13%	13%
NPV @ 8% (incl. sunk) (US\$ mn)	2,998	5,817
NPV @ 8% (2017+) (US\$ mn)	5,346	-169
Reqd Copper Price (\$/t)	7,180	7,514
C1 cash cost(\$/t)	453	306

Source: Company data, Goldman Sachs Global Investment Research

Glencore's DRC concerns have eased, ramp-up progressing

On April 22, Katanga Mining Limited announced that its JV partner in the DRC, the state-owned Gecamines, had commenced legal proceedings in the DRC to dissolve its 75%-owned Kamoto Copper Company (KCC) following its alleged failure to address capital deficiency. The alternative was to give Katanga some time to request the appointment of an expert to assess and report on KCC's financial position.

Following this, on April 27, 2018, Ventora Development Sasu served freezing orders in the DRC against Mutanda and Kamoto Copper Company for approximately \$695 mn and \$2.28 bn, respectively. According to Ventora, Mutanda had breached an agreement in which it was required to make royalty payments to Ventora. In addition, Ventora said that KCC had breached an agreement between KCC, Gecamines and AHIL for which it was entitled to damages of \$2.29 bn. On April 28, Ventora obtained from Kolwezi high court injunctions to pay against KCC and Mutanda in the amount of c.US\$2.9 bn, which, if they had become permanent, would have allowed Ventora to permanently seize the assets; this would, in our view, have been detrimental to the investment view (AHIL/Ventora own royalties on Katanga/Mutanda).

On June 12, Glencore announced the settlement of the legal dispute with Gecamines and an agreement for the resolution of the capital deficiency at Katanga's 75%-owned DRC operating subsidiary KCC. This resulted in Glencore making a one-time payment of \$150 mn to Gecamines and a \$5.6 bn write-off of the \$9 bn intercompany loan made to KCC. A couple of days later, Glencore announced that it had settled the dispute with Ventora and Africa Horizons regarding the non-payment of royalties. Mutanda and KCC will pay the royalties when they become due in non-US dollars, without involving US persons, in order to fulfil their obligations under the terms of the pre-existing contracts. We believe this has allayed investor concerns over Glencore's DRC assets being under threat of seizure.

Glencore: Katanga and Mopani ramp-up on track

Having shut down the Katanga and Mopani in 2H15 as copper prices fell, Glencore is well on the way to ramping up production at the two mines.

Katanga: The mine, located in the DRC, has now reached commercial production and is ramping up, with recent guidance pointing to production of 150kt for 2018 and 300kt in 2019. The mine recently faced legal and regulatory issues (explained above), but most have now been resolved. We still model the mine achieving its targeted production. The mine is of particular importance to Glencore given we expect it to produce 34.5ktpa of cobalt from 2019 onwards.

Mopani: Glencore has spent over \$1 bn since 2014 for the development of new shafts that are expected to increase the mine life by c.25 years. The expansion is expected to add c.90ktpa of copper, with recent news flow suggesting first production in 2H18 and full ramp-up to name-plate capacity by 2020. Given that the majority of capex has already been spent, we believe the likelihood of reaching full capacity by 2020 is high.

Exhibit 24: Glencore has four growth projects, of which Katanga and Mopani are ramping up
Freeport growth projects

GLENCORE				
Key Metrics	Katanga WOL	Mopani upgrade	El Pachon	Collahuasi
Project Status	Construction	Construction	Pre-feasibility	Pre-feasibility
Start Year	2017	2018	2026	2025
Capex (\$ mn)	1,159	1,025	2,026	4,350
Average Production (ktpa)	274	95	277	292
Life of Mine	17	26	25+	26+
IRR (%)	198%	19%	13%	15%
NPV @ 8% (incl. sunk) (US\$ mn)	17,184	2,126	1,699	2,888
NPV @ 8% (2017+) (US\$ mn)	17,567	3,161	1,699	2,888
Required Copper Price (\$/t)	-1,243	5,489	10,029	6,651
C1 cash cost(\$/t)	-2,170	2,333	3,534	3,229

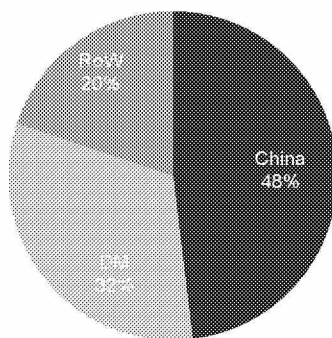
Source: Company data, Goldman Sachs Global Investment Research

Demand: Outlook has muddled, but overall remain positive

At the start of the year, we were positive on copper, led primarily by the fact that even as China was slowing, the rest of the world (DMs and EM ex. China) was growing at a very strong rate – the DM CAI (a proxy for growth) was at 3.6% as at January 2018 and EM CAI was at 7.1%. These numbers remained strong, while the further slowdown that the market appeared to be expecting in China did not materialise. China CAI strengthened from 7% as of December 2017 to 8% in February 2018.

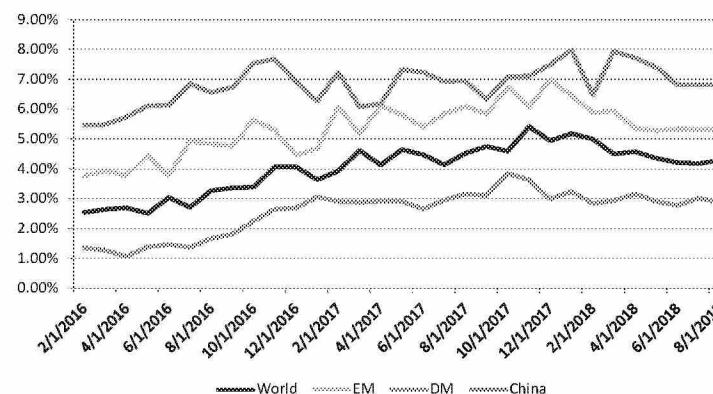
More recently, however, the view has changed. EM growth has been a source of investor concern given disappointing data coming out of South Africa and the recent slowdown in Turkey, among others. DM growth has also come down from very high levels – 3.6% (CAI) as of December 2017 – to a more normalised level of 3%. China remains a key uncertainty, with growth being very volatile.

Exhibit 25: China and DMs form c. 80% of the total copper demand
2017 copper demand by region



Source: Wood Mackenzie

Exhibit 26: Growth expectations, while still high, have reset to a more normalised level
Current Activity Indicators



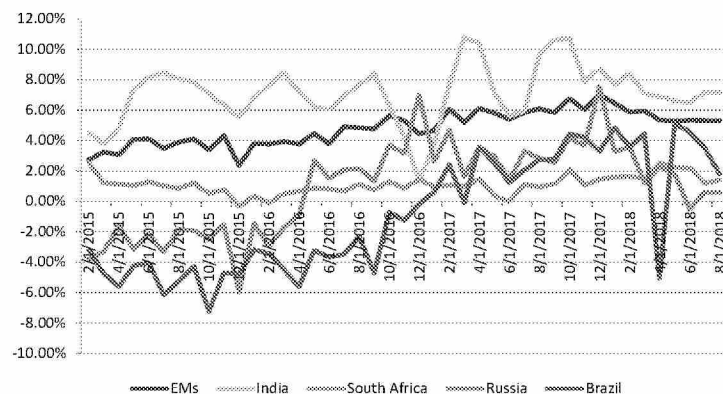
Source: Bloomberg

Growth, especially in EMs, has been negatively affected by recent developments

Both DMs and EMs (ex. China) are continuing to grow at a healthy pace despite the recent speedbumps. The majority of the recent concerns by investors have related to EMs, with DM growth remaining strong:

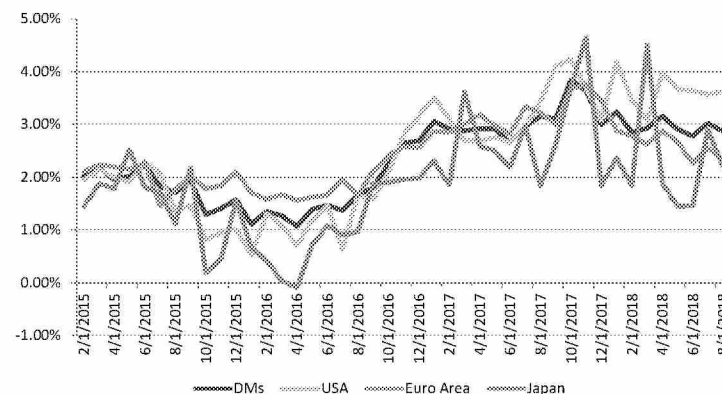
- **EMs:** Emerging markets ex. China have been under the spotlight recently, especially after the currency events in Turkey. This brought to the forefront growth concerns that had been present for the past few months, particularly in economies such as South Africa (which printed negative GDP growth in 2Q), Argentina, Russia and Brazil among others. Despite the recent developments, our economists expect roughly flat EM growth over the last three months (with the CAI at 5.3% in August).
- **DMs:** Despite the recent slowdown in the Euro area (where the CAI has come down from 3.75% to 2.55%), the overall CAI has remained robust at around 3%. Strong DM growth has been a function of strong US growth, among others. Our economists remain positive on DM growth, forecasting GDP growth of 2%-3% over next three years.

Exhibit 27: While some countries in EM have been choppy, growth has remained robust EM CAI



Source: Bloomberg

Exhibit 28: DM growth has been more robust despite some economies registering choppy growth DM CAI



Source: Bloomberg

China: Recent data has been disappointing, but policy stance supportive

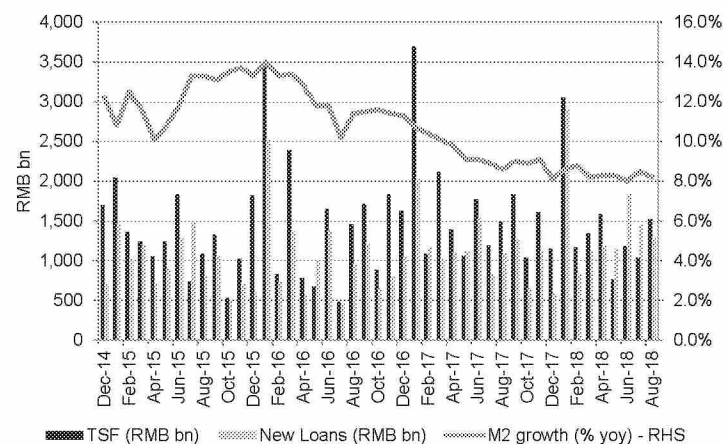
Recent China data has been disappointing, primarily the hard data that came out for the month of July, such as industrial production and FAI. This comes amid a focus by policymakers on targeting shadow lending activity to control financial risks. While our economists believe the campaign to curtail the shadow banking portion of credit has been successful (total social financing has been less than new loans for the last three months), some investors have been concerned that continued tightening will lead to China growth slowing given the disappointing data over the past couple of months. Against this backdrop, our economists believe there are other tools at the disposal of policymakers to ensure growth remains robust, as we discuss in the next section.

Exhibit 29: China data has been disappointing, both soft (PMI) and hard (IP)...



Source: Bloomberg

Exhibit 30: ...amid tightening credit (mainly reflecting a government focus on shadow banking)



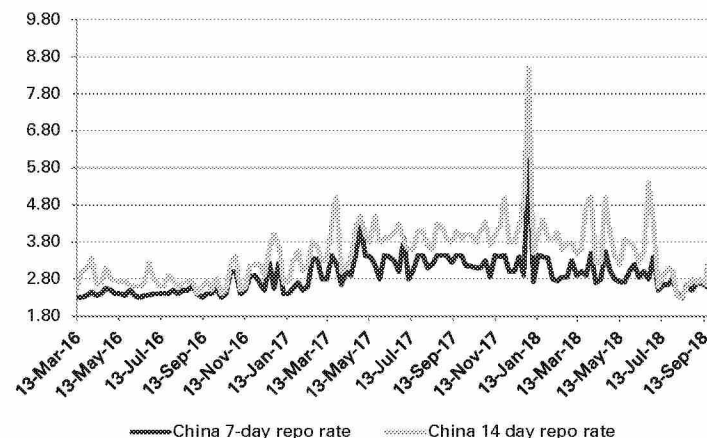
Source: Bloomberg

Recent policy comments have been supportive of growth

More recently, the rhetoric from China's policymakers has turned supportive of growth. This has come as more recent activity data has been disappointing amid the ongoing trade tensions. Policymakers have started loosening despite maintaining their focus on shadow banking. The loosening has been via other mechanisms – cutting money market rates and increasing the size of new loans (loans offered via official channels). In addition, for the first time in almost a year, policymakers have started to approve infrastructure projects, which is a clear positive for commodity prices.

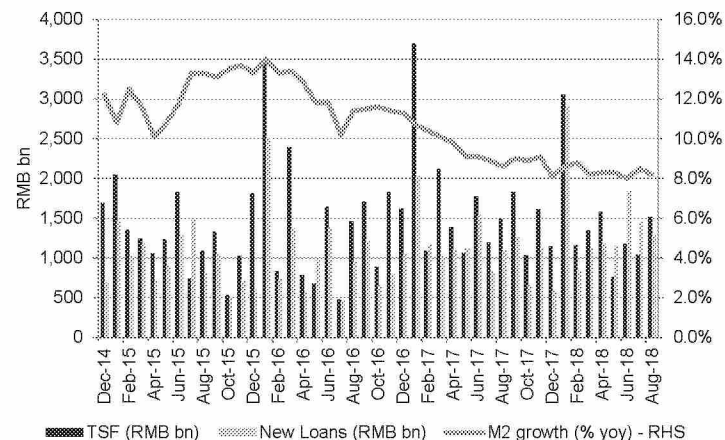
- The PBOC report released recently extended the dovish tone of policymakers. Our economists see increased flexibility by the PBOC to cut interest rates on key monetary facilities (e.g. OMOs) to guide funding costs lower as needed. The quarterly report highlighted that fiscal, regulatory and structural support is required to ensure effective monetary policy transmission.
- Money market rates have continued to drop, with the interest rates on short-term loans between Chinese banks having sunk to three-year lows in a bid to boost onshore demand. Our economists continue to expect policymakers to guide rates down to support growth.

Exhibit 31: China money market rates have dropped significantly



Source: Bloomberg

Exhibit 32: Most recent money data from China has been strong too



Source: Bloomberg

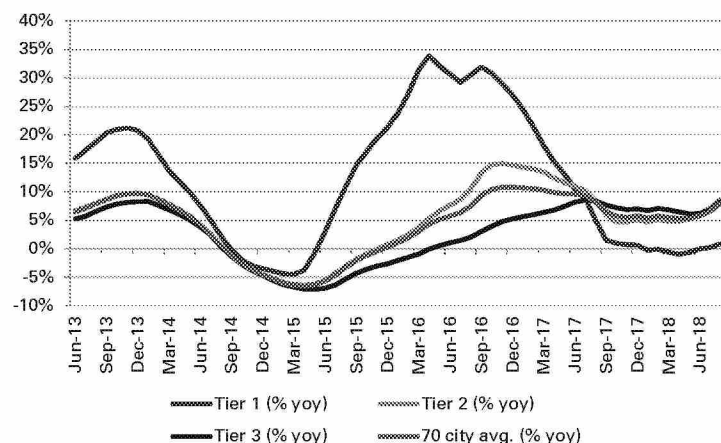
China property: While restrictions likely to remain in place, demand remains robust

The Chinese property market is likely to be biggest risk facing the Chinese economy and thus copper demand in the next 12 months, bar any significant escalation in trade tensions. Policymakers have been focused on restraining rising house prices by reining in speculative demand, and have considered imposing property taxes on homes in order to stabilise prices. Throughout 2017, the policies had the highest impact on property prices in Tier 1 cities, where prices fell throughout most of the year. However, the recent rebound in prices has been reflected in growing confidence from the country's developers as new starts have begun to rise again.

Property remains the biggest unknown in the Chinese demand equation. There has been conflicting news flow (Bloomberg) around what policymakers are looking to do. Some reports have suggested that China could seek to ban pre-sales (SHRPROP, the China property index, was down 3% on this news), while other reports have suggested that Shanghai could look to relax rules on mortgages, which would be a positive for demand. Overall, however, the data from China continues to look solid.

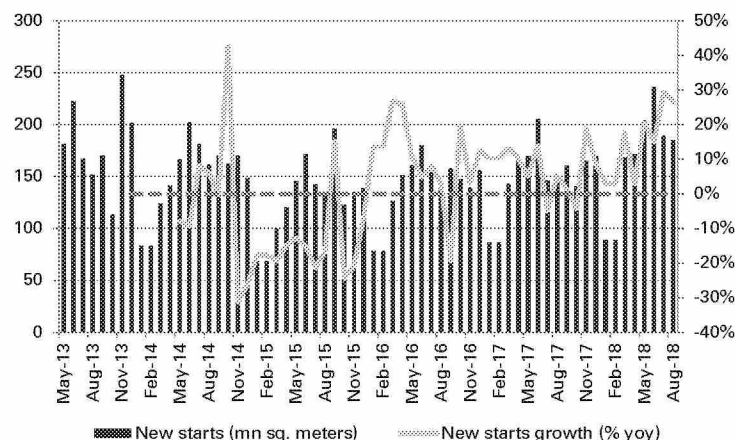
An important point to remember is that while property prices might decline, new starts are key, as they are the main determinant of commodity (including copper) demand.

Exhibit 33: Property prices have risen despite stringent restrictions applied by policymakers
China property prices (by tier)



Source: Bloomberg

Exhibit 34: New starts have begun to rise as higher profits have driven developers to increase development activity
China property new starts



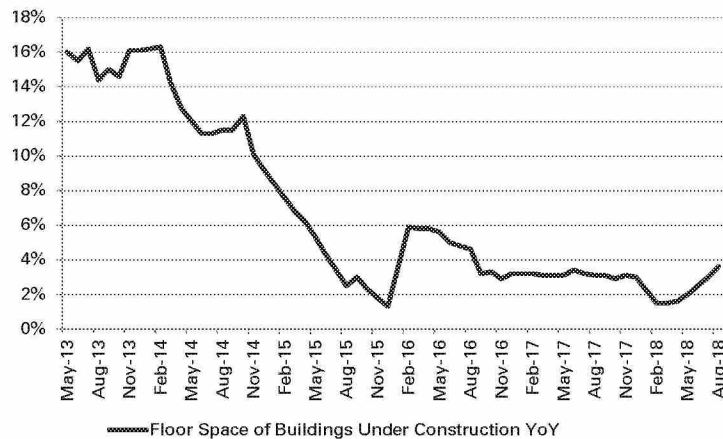
Source: Bloomberg

Future property pipeline looks robust; should be positive for demand

As discussed above, property datapoints – new starts and property prices – have been robust this year despite significant investor positioning to the contrary early in the year. While this is important, future demand is our focus in this section. Early data points indicate a strong pipeline of property development: floor space of buildings under construction and land sales have been strong YTD. This, in our view, is likely to be positive for future copper demand, as there is a lag of 18-24 months between construction starting and copper demand manifesting.

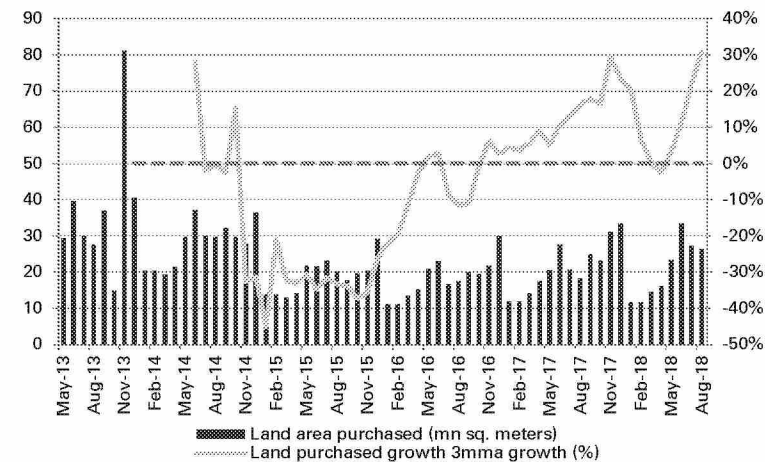
Exhibit 35: Growth of floorspace construction has rebounded this year, which is a positive for copper demand

Floor space of buildings under construction (% yoy)



Source: Bloomberg

Exhibit 36: Land purchased by property developers has been rising
China land purchased for construction activity



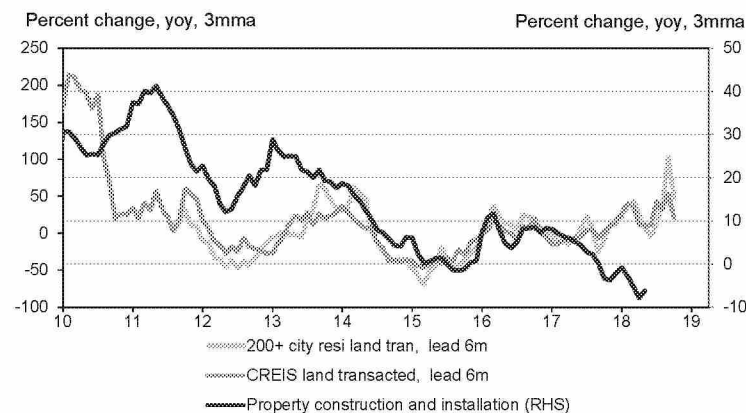
Source: Goldman Sachs Global Investment Research

See upside in fixed investment as policymakers look to shore up growth

In a recent note, our economists noted that the “policy put” from policymakers is likely to come from a pick-up in infrastructure spending.

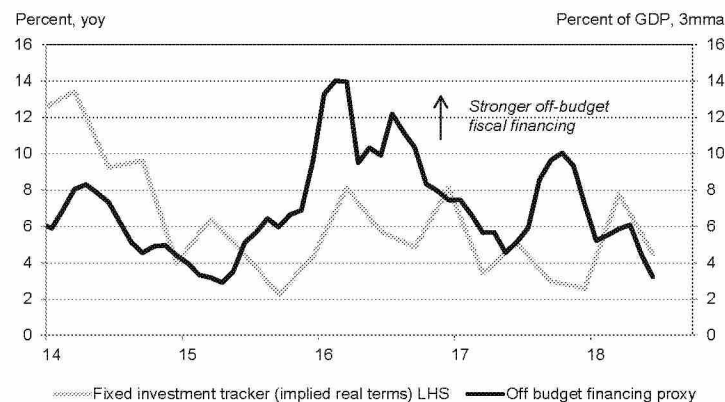
- Our economists see potential for property construction growth to normalise higher. Exhibit 37 illustrates the divergence in the trend of property construction vs. land transactions over the last half a year, but the recent faster home sales should help unclog the property pipeline and support a narrowing of this gap. Still more importantly, given the policy focus on local government spending as a primary lever to manage growth, they expect stronger infrastructure investment in the coming months to largely offset any residual weakness in headline activity.
- They also believe that a meaningful increase in their proxy for off-budget fiscal financing would send a favourable signal for near-term fixed investment. The proxy was still subdued for July, but in August the pace of special municipal bond issuance (a main sub-component of their proxy) encouragingly accelerated further, to more than RMB400 bn, and they believe that it should remain strong in the next two months.

Exhibit 37: Upside potential for property construction in the coming months



Source: CREIS, CEIC, Goldman Sachs Global Investment Research

Exhibit 38: A rise in off-budget fiscal financing would send a favourable signal for near-term fixed investment



Source: Goldman Sachs Global Investment Research

Electric vehicles driving demand for copper

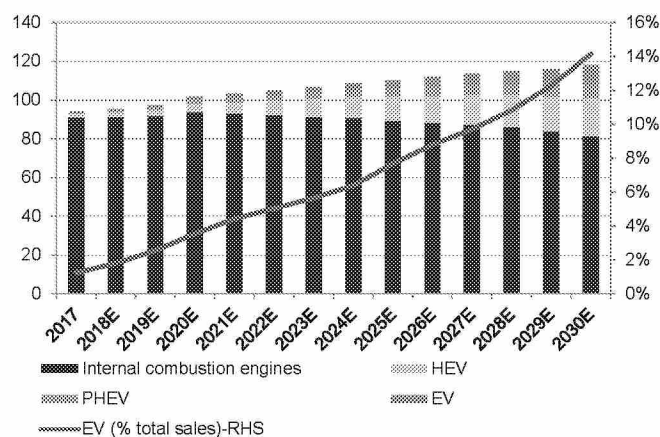
The future of EVs is ultimately dependent on supportive policy and sufficient infrastructure development (e.g. charging). Following our original analysis of the impact for copper demand in 'Copper: Top Projects 2017', we extend our forecasts to 2030 and add a consideration for the charging infrastructure that will be required alongside the copper that the vehicles will demand. Analysis by our Autos team suggests EV penetration could reach 8% by 2025 (see 'Electric Vehicle Boom: ICE-ing the combustion engine') and gain momentum from there, resulting in a potential cumulative incremental copper demand of 21.8 mn tonnes by 2030 including charging units. Given that the growth of EVs could vary significantly, we consider bull/bear cases that imply cumulative copper demand of 18.8 mn/27.9 mn tonnes respectively over the next 13 years.

EV penetration at 8% by 2030 demands 4.4 mn tonnes of copper by 2030

Copper's high electrical conductivity and efficiency make it an important metal for electrification. Not only is it found in the electric motor, but in the battery and cabling of electric vehicles; copper content scales up from 39kg in hybrids to 83kg in fully battery powered vehicles. At an EV penetration rate of 8% by 2030, we forecast copper demand to reach 7.5 mn tonnes cumulatively from PHEVs (plug-in electric vehicles) and BEVs (battery electric vehicles) combined.

Exhibit 39: EVs and PHEVs to reach 14% of the global fleet by 2030E, as ICEs are gradually phased out...

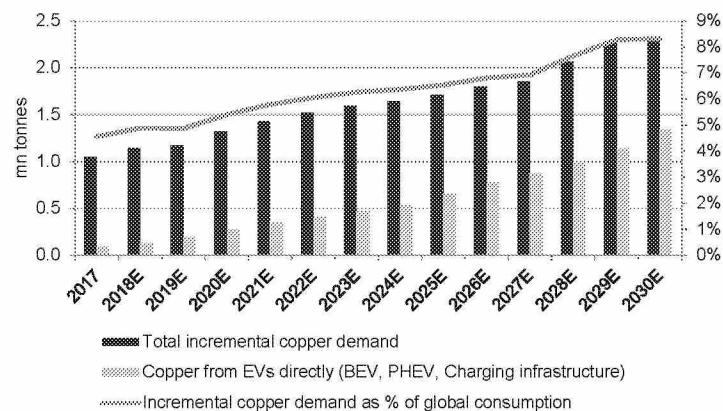
Vehicle sales (millions)



Source: Goldman Sachs Global Investment Research

Exhibit 40: We estimate copper demand from EVs to reach 8% by 2030, a cumulative 7.5 mn tonnes from 2018

Incremental copper demand of BEVs combined with charging infrastructure, total demand from vehicles and % of global copper consumption



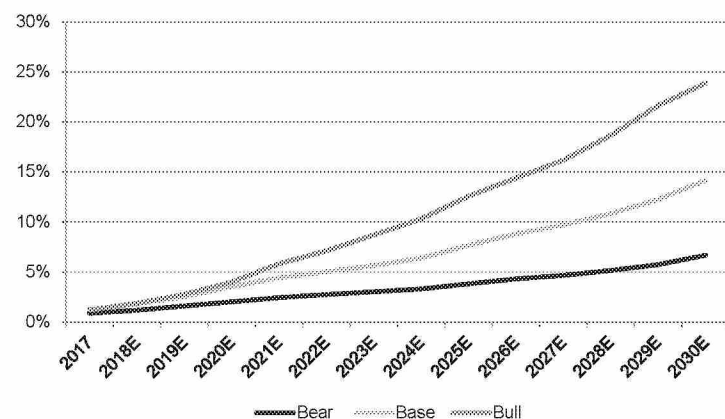
Source: Goldman Sachs Global Investment Research

The bull and bear case for copper based on EV penetration

Government policy will be crucial to EV growth. Incentives, including subsidies, have potential to promote an increased market share. Similarly, the withdrawal of such benefits could result in a slowdown in EV adoption (e.g. as in Denmark). However, the cost of the battery is also influential, and as it continues to decrease, EV sales should increase significantly. Our Autos team forecast a rapid uptake in EVs once the payback period hits three years. For the bear case, we have adjusted the relative share of each vehicle type such that EVs with PHEVs represent only 4% of total vehicles in 2025 (vs. 8% in the base case and 14% in the bull case). This could be a more likely scenario if governments are slow to encourage their populations to buy an electric vehicle, or do not invest enough in the necessary infrastructure.

Exhibit 41: The rate at which EVs gain a share of the global fleet is dependent on policy, battery cost and infrastructure

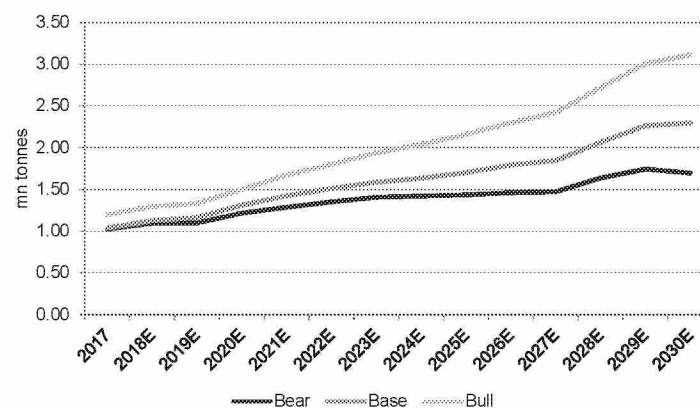
Bear/base/bull case for EVs and PHEVs as % of total autos



Source: Goldman Sachs Global Investment Research

Exhibit 42: Depending on this penetration rate, incremental cumulative copper demand could range from 18.8 mn to 27.9 mn tonnes by 2030

Bear/base/bull case from incremental copper demand in mn tonnes



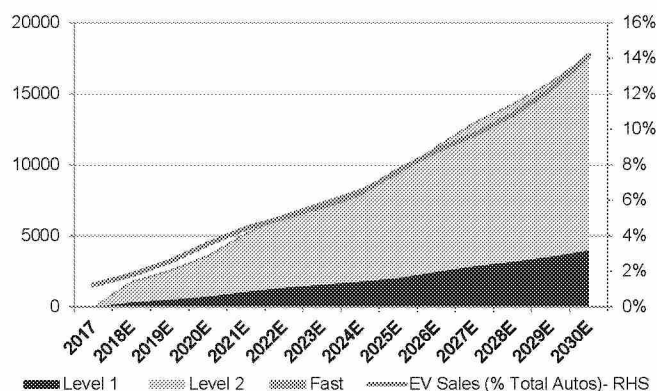
Source: Goldman Sachs Global Investment Research

Electric vehicles need to be charged...

Currently, development in charging infrastructure is slow. This is a chicken and egg situation: drivers are reluctant to purchase electric vehicles until there is sufficient charging infrastructure, while governments are hesitating to provide such infrastructure until battery-powered cars become more dominant. In their report 'From Pump to Plug', our colleagues forecast the investment required for sufficient charging infrastructure by charging habits and charger types. EVs will likely primarily be charged by Level 1 and 2 chargers at home and at work, and may be wall-mounted or pedestal. Level 2 chargers are expected to dominate, with most cars being charged overnight as this would be sufficient to cover the majority of journeys (<200km). Level 1 chargers (1.3-1.9kW) are able to cover >75% of typical trips driven a day, but for the <6% of journeys over 200 km, fast chargers (50-150kW) along motorways will boost range. Resultant copper demand has been calculated on the assumption (based on data compiled by Goldman Sachs) that Level 1 and 2 chargers contain 0.25kg of copper per kilowatt, while fast chargers have 0.04kg Cu/kW. Furthermore, we assume that Level 1, 2 and fast chargers have charging capacity of 1.9kw, 7kW and 75kW respectively. Various estimates by industry experts suggest that copper demand from required infrastructure is equivalent to 4-9x that of charging units, for which we input 4x. Hence, combined with the annual additions of charging units by type, the copper demand from charging infrastructure scales up from 0.02 mn to 0.1 mn tonnes over the next 13 years. Given that the demand from the charging units alone is small relative to the vehicles, our rough estimate for additional charging infrastructure of 4x vs. 9x is likely to have little impact.

Exhibit 43: Level 2 chargers to dominate the infrastructure, with <6% fast chargers required for backup...

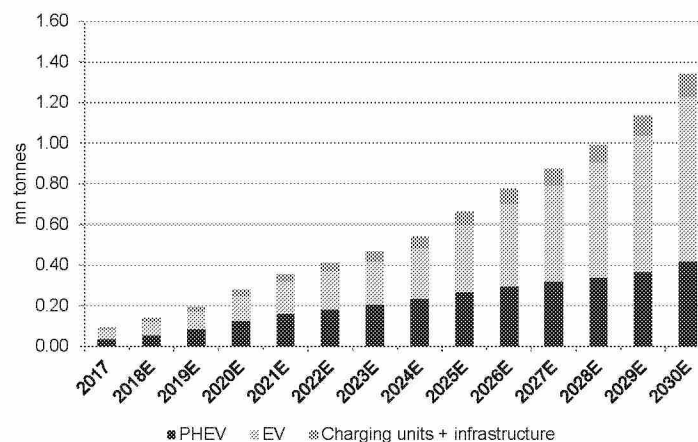
Charging additions (millions of units) for each charger type alongside EV penetration rate...



Source: Goldman Sachs Global Investment Research

Exhibit 44: ...but the amount of copper in the chargers is a small fraction of that in the vehicles themselves

Copper demand from electric vehicles and charging units in millions of tonnes



Source: Goldman Sachs Global Investment Research

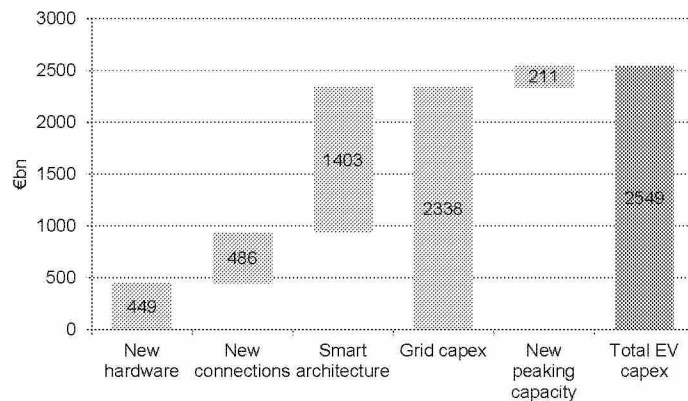
...and chargers need to be connected to the grid

While the charging units alone demand a relatively small amount of copper, the cabling between units and connection to an electricity supply will require more. An EV global fleet penetration of 10% would require 220 mn chargers and c.\$800 bn of grid investment for transformers, new lines and smart infrastructure. However, once EV penetration surpasses 25%, the grid itself will need to be upgraded to cope with increased electricity demand (note that one home-charging unit is considered to have the same demand as a whole house). Considering hypothetical full electrification, the capital expenditure requirement could amount to c.US\$2.3 tn for charging infrastructure alone, in addition to c.US\$2.6 tn for the power network. Furthermore, the large percentage of copper in potentially necessary new transformers and substations for a grid upgrade could inflate our estimate for total copper demand, assuming that there are more installed than replaced, but such data is difficult to obtain reliably.

Limitations on fast EV adoption relate to the number of electric vehicles coming to market, how fast they come to market and how electricity supply will have to be upgraded to cope with increased demand.

Exhibit 45: To support full electrification by 2050, the grid would need to be upgraded completely, requiring significant investment...

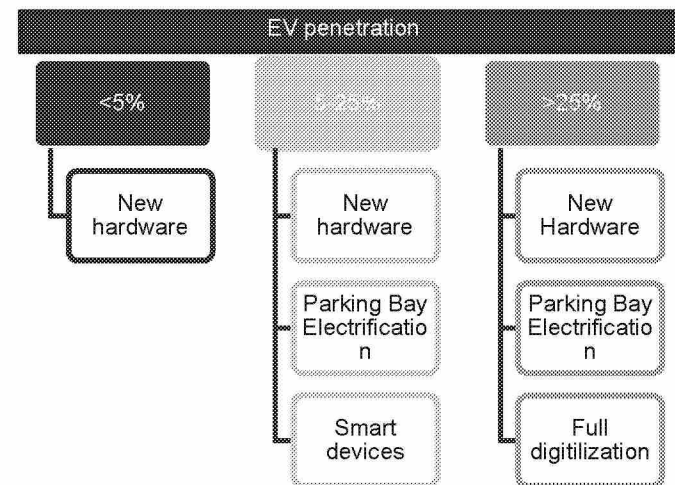
Capital expenditure required for each component of EV infrastructure in € bn by 2050



Source: Goldman Sachs Global Investment Research

Exhibit 46: ...which will scale with the EV penetration rate

Infrastructure required as EV penetration increases



Source: Goldman Sachs Global Investment Research

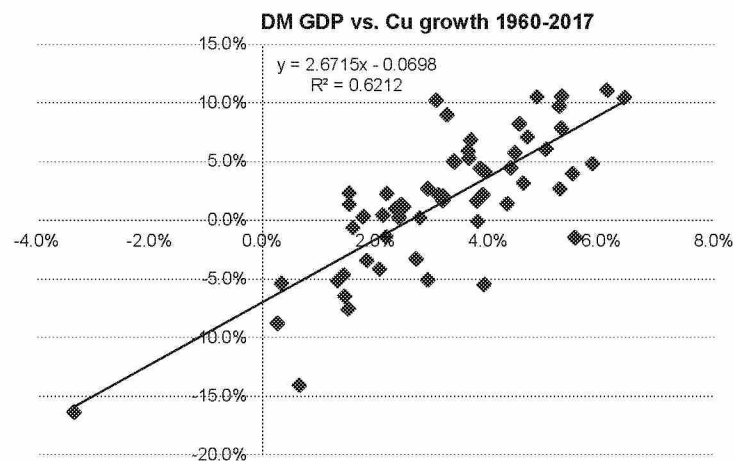
Strong DM growth to see consumption to increase, albeit at a low rate

Copper demand in developed markets (DMs) grew by an average c.2.8% pa over the 40 years to 2000. However, with the shift of production to the east, and stagnating economic growth over the past decade, DM copper consumption growth ran out of steam (2001-16 average copper consumption contracted at an average rate of 1.6%). While previously, we expected copper consumption in DMs to continue to decline, given the recent strength in growth, we now expect consumption to grow in the next few years.

Copper consumption intensity in DMs has peaked, however, and is on a path of slow decline. Our Commodities team forecasts copper consumption in OECD countries to grow this year and next before flattening out in 2020. One of the factors underpinning our positive thesis on copper is above-trend DM growth. Developed market copper consumption growth shows a relatively strong correlation to GDP growth over both periods; we observe a slightly stronger relationship more recently, with the R^2 increasing to 0.64 from 0.62 in 1960+.

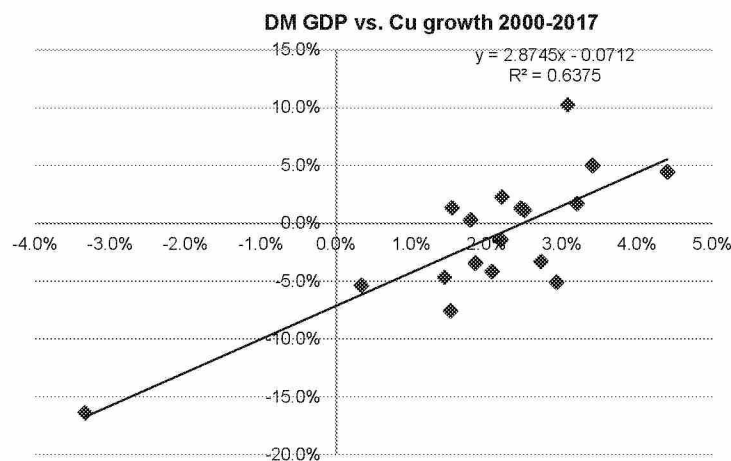
The exhibits below show the relationship between developed market copper consumption growth and GDP growth since 1960, and in 2000-17, respectively.

Exhibit 47: DM copper consumption correlates with GDP growth
Developed market copper consumption growth vs. GDP growth 1960-2017



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 48: Stronger correlation to GDP growth over the past ten years
Developed market copper consumption growth vs. GDP growth 2000-2017



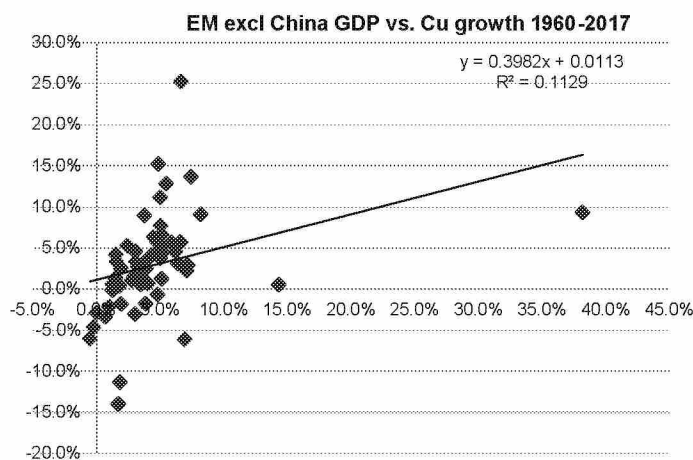
Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Fixed investment the key in EMs

Copper demand in emerging markets (EMs) grew by an average c.4.1% over the 40 years to 2000, accelerating to c.8% in 2000-17. However, most of the growth over the past decade has resulted from the emergence of China. Chinese copper consumption growth has averaged 12% pa over the past 17 years, with other emerging economies averaging growth of 4% pa. This bifurcation in copper consumption growth requires that we separately forecast copper demand for China and other emerging economies. First, we look to identify the main economic drivers of copper consumption growth. The exhibits below show the relationship between copper consumption growth and GDP growth since 1960 in China and other emerging economies.

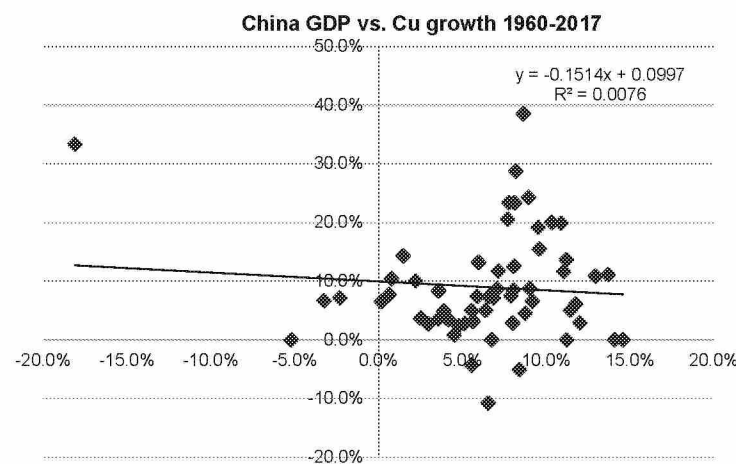
It is evident that over this period, there has been no clear relationship between copper consumption growth and GDP growth in China or other emerging economies. We believe the main reason for this has been the planned nature of development and central government backing in China and the former Soviet Union, which makes the level of fixed asset investment (FAI) a more relevant metric.

Exhibit 49: Little copper consumption and GDP growth correlation in EMs...
EMs ex. China copper consumption growth vs. GDP growth, 1960-2017



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 50: ...and China
China copper consumption growth vs. GDP growth, 1960-2017

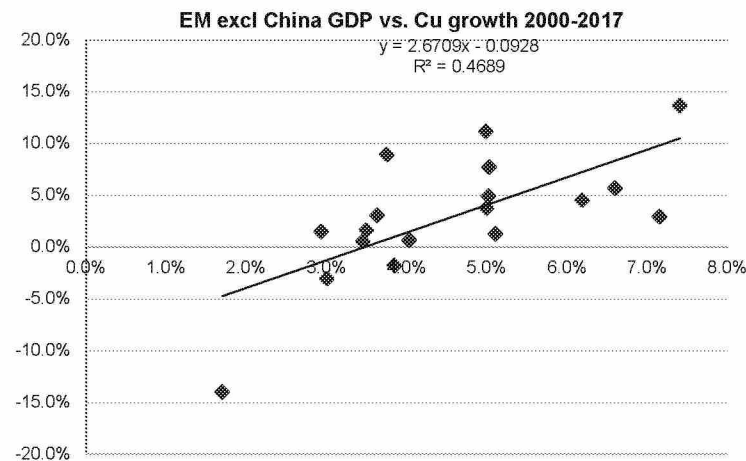


Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

The Soviet Union comprised up to 70% of total copper consumption in emerging markets excluding China until the 1980s; however, the collapse of the Soviet Union significantly changed the dynamics of commodity consumption in the region. That being the case, we look at how the copper consumption growth to GDP growth relationship has changed in the post-Soviet era, excluding the period of stagnation and uncertainty of the 1990s.

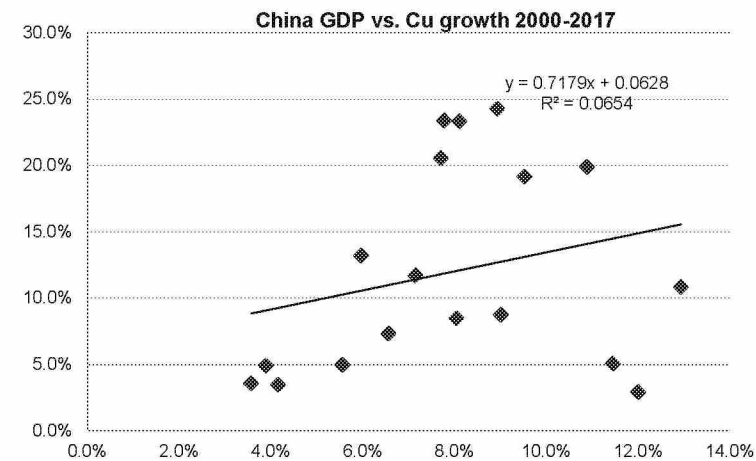
As expected, post-Soviet period copper consumption growth displays a stronger correlation to GDP growth, as the latter now relates more closely to market fundamentals than central government spending. Given the relatively strong correlation of non-China emerging markets copper consumption to GDP growth in the post-Soviet era, and for the sake of simplicity, we run copper demand sensitivities on the prevailing trend over that period. We assume (based on our economists' forecasts) an average GDP growth rate of c.5.5% in 2018-20. Based on the relationship over the past ten years, this would imply c.2.7% annual copper consumption growth, with every 0.1% move in our GDP assumption affecting our copper consumption growth forecast by c.0.4%.

Exhibit 51: Copper consumption to GDP correlation in post-Soviet era...
EM ex. China copper consumption growth vs. GDP growth, 2000-16



Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

Exhibit 52: ...but lack of correlation remains in China
China copper consumption growth vs. GDP growth, 2000-16



Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

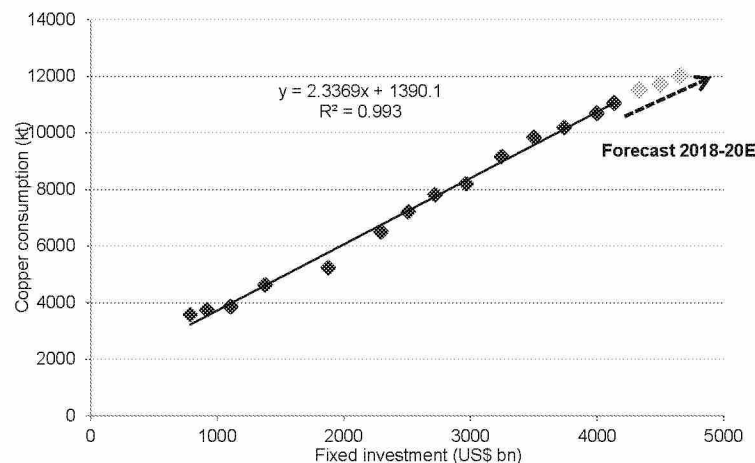
Copper consumption in China has been a function of FAI spend; focus shifting to value of growth from absolute

From 2004 onwards, China invested a significant proportion of its budget in fixed asset investment to bolster growth. This led to double-digit demand growth for almost all commodities (including copper). For the last 3-4 years, we have used this metric to forecast Chinese copper demand. However, we now believe that the trend is changing. The focus of the government has clearly shifted from an investment-driven growth model to a more consumption-driven model.

Of note, there is no evident change in the allocation of fixed investment to copper-intensive growth, with the slope little changed through the past ten-plus years. This is contrary to what we observe in steel, where there has been a clear flattening of the slope in the years following the global financial crisis compared with the previous five years since the emergence of China. Copper being an early- and medium-cycle commodity plays a part in this relationship, and our current copper demand growth forecast for China implies a continuation of the fixed investment to copper consumption growth relationship.

Exhibit 53: Strong correlation between Chinese fixed investment and commodity consumption on an absolute basis...

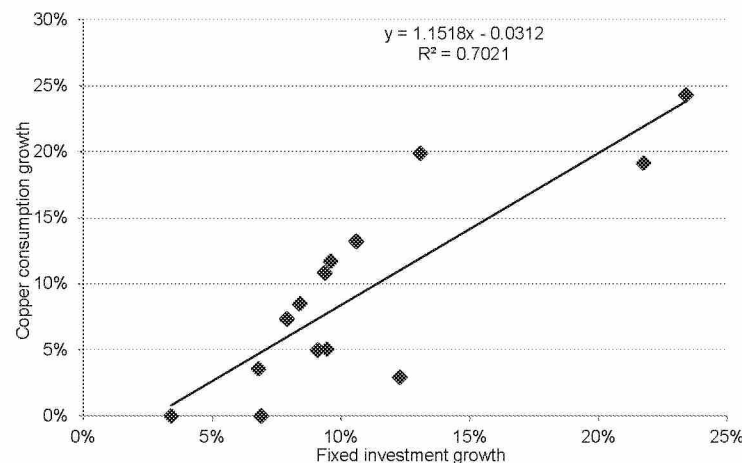
China's copper consumption vs. fixed investment



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 54: ...and in terms of growth

China's copper consumption growth vs. fixed investment growth



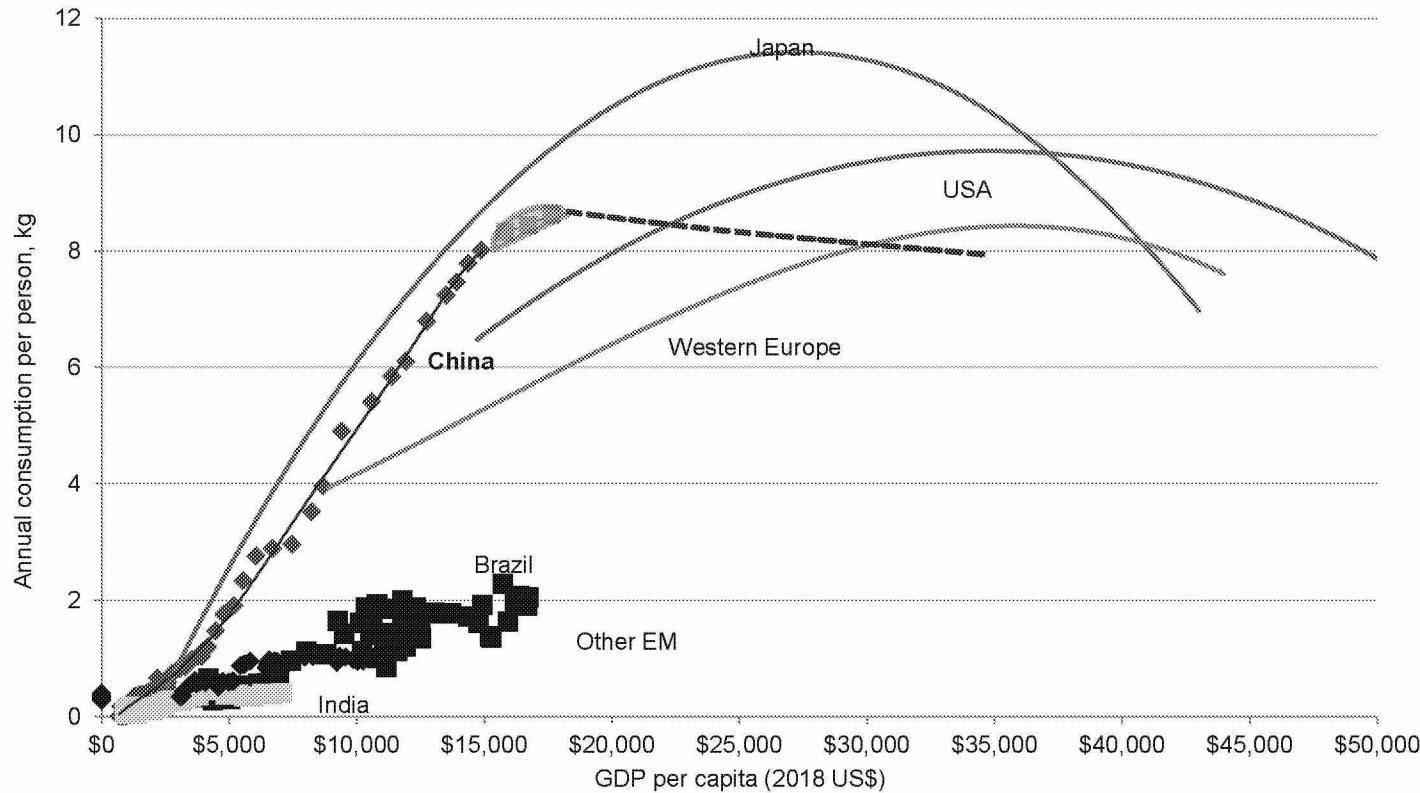
Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Capex intensity softening in DMs but absolute demand still growing; expect China to remain strong

There are three trends to note in the chart below that we believe are important for copper demand in the near future:

- 1. China:** China demand has been at the centre of discussion for the last few years, which is where we believe the market, including us, underestimated total demand. Over the last couple of iterations of our Top project analysis, we had forecast Chinese consumption to decrease, in line with our economists' forecasts of weaker Chinese growth. However, that has now changed as our economists are more confident in China's growth prospects, which makes our commodities team positive on Chinese copper growth – they forecast growth of c.2.9% over the next three years.
- 2. DMs:** We expect copper intensity to continue to weakening in DMs. However, we believe that the absolute level of copper consumption is still growing, especially in economies exhibiting strong growth, such as the US. Therefore, despite the weakening in copper intensity, we continue to expect copper demand to grow – our commodities team forecasts growth of c. 0.5% over the next three years.
- 3. EMs:** EMs have shown weaker trends more recently, especially with growth in South Africa continuing to disappoint (as of 2Q18, the country has entered a technical recession). The concerns more recently have been magnified by issues in Turkey, Argentina and Indonesia. India has been the only bright spot, with growth remaining strong. However, it is worth noting that even as EM growth has been tepid, EMs do not constitute a big portion of the copper demand – our commodities team forecasts growth of c.3.5% over the next three years.

Exhibit 55: China growth flattening; a long way to go for EM per capita copper consumption to make a sizable impact on S-D
Per capita consumption for copper vs. GDP per capita at main economies



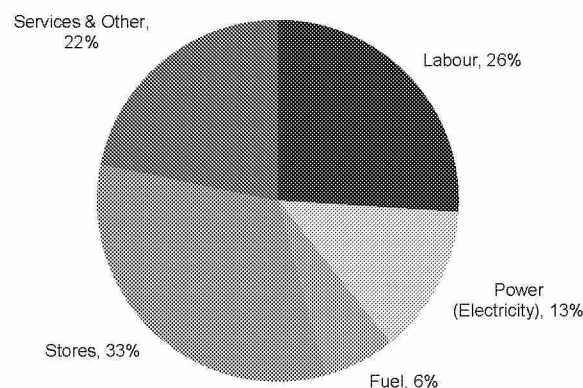
Source: The Conference Board Total Economy Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Costs have bottomed out, inflation is back

The common theme until last year was that costs were on the decline owing to weaker FX, lower wages and lower consumables (oil/steel etc.), among other factors. Following some tentative signs of a return last year, inflation is now clearly back in the mining system. In their FY17/1H18 results, most of the copper companies in our global coverage reported cost inflation anywhere between 3% and 11%. In this section, we investigate the major reasons for the inflation, and outline our outlook for the next few years.

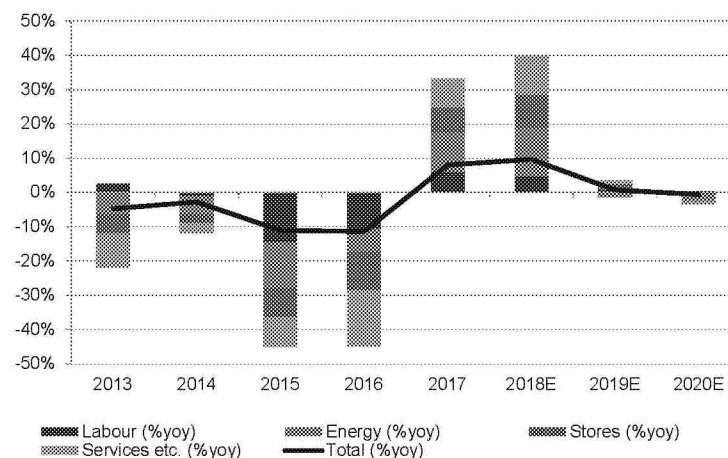
- **Labour costs:** Labour costs have escalated materially, with companies more often than not agreeing to the majority of increases proposed by mining unions amid a heightened threat of strike action compared with over the past 4-5 years.
- **Power (electricity and fuel),** which forms c.17% of the total cost base, is another area where base effects are likely to result in cost inflation. Oil prices have rallied materially, and our commodities team remain positive on the oil price over the next 12-18 months. This, coupled with high thermal coal/natural gas prices, has meant that the entire energy complex has been strong, implying high energy costs for mining companies.
- **Consumables,** especially steel, have also been strong, which has been another cause of inflation for the mining companies.

Exhibit 56: Labour, store and services form the bulk of the cost base
Average copper cost components – 2017



Source: Wood Mackenzie

Exhibit 57: Costs are set to rise materially
% changes yoy



Source: Wood Mackenzie.

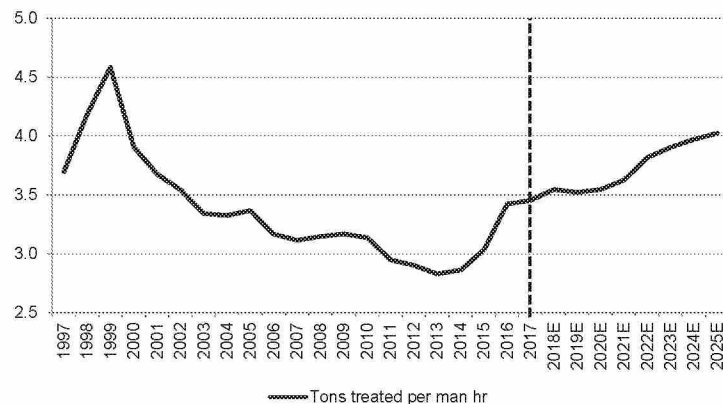
Productivity: Copper has lagged, room for improvement

Productivity is one area where copper companies have lagged, materially. While it has ticked up over the past couple of years, data from Wood Mackenzie shows that there is significant room for further improvement. If productivity does increase, the effect is likely to be deflationary, as it leads to more production and thus lower unit costs.

However, an interesting point to note is that the decline in productivity from 1998 to 2014 occurred in a period of continued copper price strength. The only time productivity did increase was when copper prices crashed (2014-16). This was likely a function of copper companies focusing more closely on their operations and cash flow, a focus that tends to increase when commodity prices are lower and decrease when they are higher.

Exhibit 58: There is significant scope for improvement in tonnes treated per man hour...

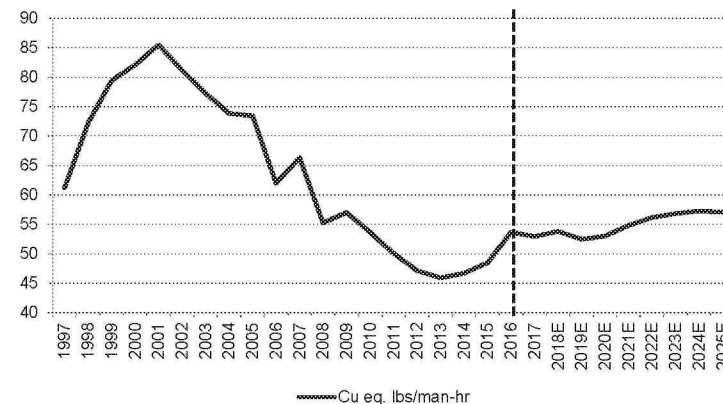
Tonnes treated per man hour



Source: Wood Mackenzie

Exhibit 59: ...and copper equivalent production per man hour

Copper equivalent production per man hour



Source: Wood Mackenzie

Copper Top Projects: Key takeaways from our supply-side analysis

As part of our 2018 Copper Top Projects work, we have analysed 84 projects. We have made multiple changes with this iteration, which we detail later in this section. Key conclusions based on our work are:

- **Incentive price required to bring the 84 projects online** at a 17% IRR is US\$7,067/t, up 33% from US\$5,204/t last year. Note that over the life of mine, these projects potentially represent c.13 mn tonnes of copper supply. The reasons for the big increase in the required prices are:
 - Cost/capex/consumable inflation (e.g. oil).
 - Required IRR: We have increased the required IRR for the projects from 12% to 17%, a function of how we calculate the IRRs.
- **The incentive price required to bring the 33 risked projects** (projects that have been approved) is US\$6,799/t, up c.34% yoy. Note that over their life of mines, these projects represent c.4.3 mn tonnes of copper supply.
- **Incentive price required to bring the 51 unapproved projects online** is c.US\$7,307/t, up 36% yoy. This compares with the spot price of US\$6,250/t. Over the life of mine, these mines represent c.8.8 mn tonnes of copper supply.
- **Environmental/social and political concerns** have resulted in a number of projects being either pushed out or suspended pending further review, which provides a further fillip to prices in the longer term, in our view.

Additions/deletions since Copper Top Projects 2017 analysis

We have removed the following projects because they have either fully ramped up, or the ramp-up is off the table: Bozshakol (Kaz Minerals), Bystrinsky (Norilsk Nickel), Encuentro Oxides (Antofagasta), Escondida ramp-up (BHP/Rio), and Kinsenda (Jinchuan Group International Resources).

New additions since our 2017 Copper Top Projects:

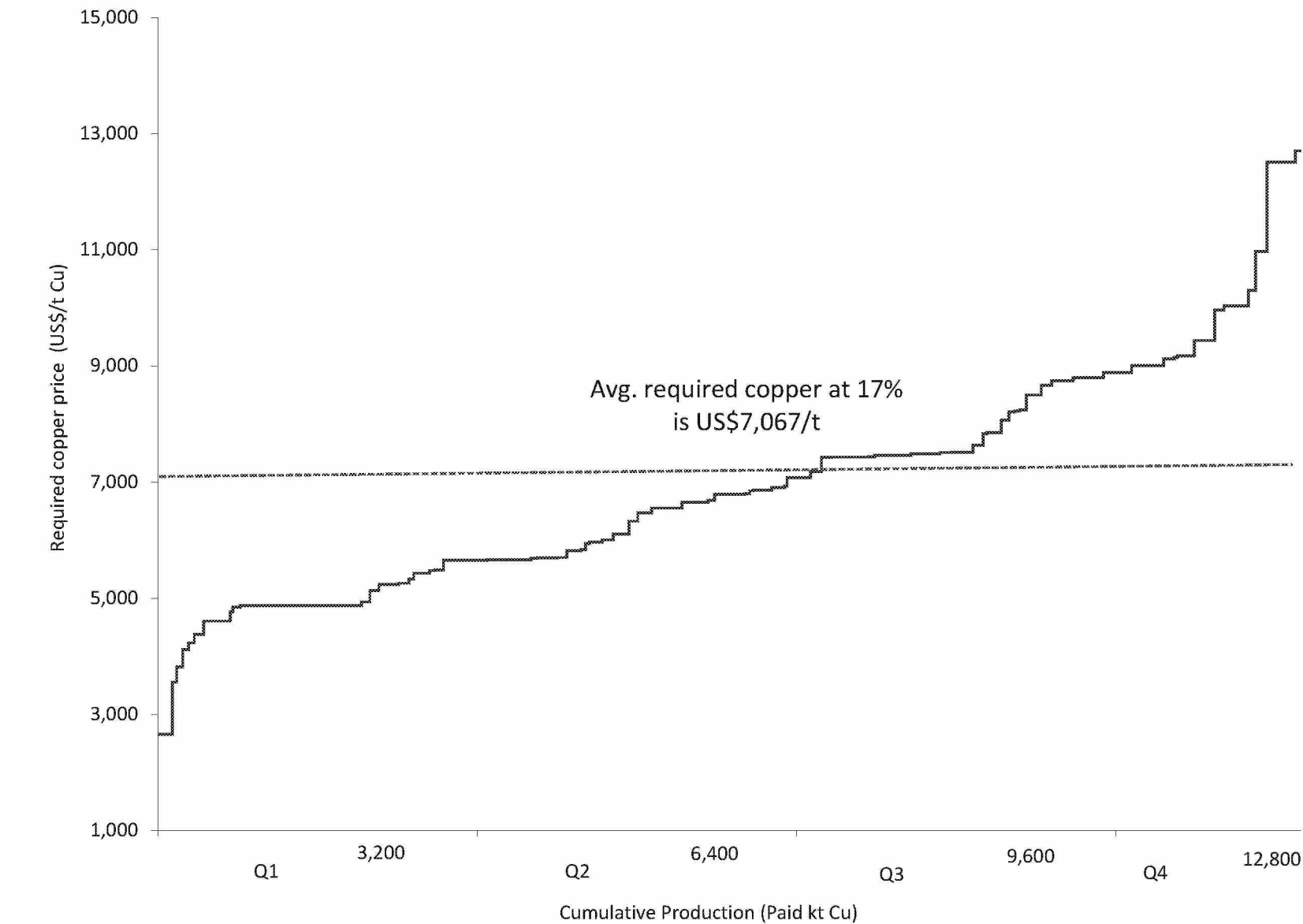
- Chambishi project in Zambia, owned by China Non-Ferrous metals and ZCCM
- El Abra project in Chile, owned by Freeport and Codelco
- El Arco project in Mexico, owned by Southern Copper
- Florence Copper in Phoenix, USA, owned by Taseko Copper
- Galore Creek in Canada, owned by TECK Resources and Newmont Mining Corporation
- Lone Star in Arizona, USA, owned by Freeport
- Los Azules in Argentina, owned by McEwen Mining
- Los Chancas in Peru, Chile, owned by Southern Copper
- Mantoverde in Chile, owned by Mantos Copper
- Michiquillay in Peru, Chile, owned by Southern Copper
- Salobo 3 in Brazil, owned by Vale
- San Nicolas in Mexico, owned by TECK Resources
- Vizcachitas in Chile, owned by Los Andes

As a result of higher assumed capex inflation across the board, and the additions/deletions of projects since our 2017 GS Top Copper Projects analysis, the average capital intensity of copper equivalent production has risen c.5% to US\$14,869/t, from US\$14,147/t. This is far above historical levels, and we believe that the increase in capex intensity in this iteration of GS Copper highlights: (1) the current inflationary environment; and (2) how companies have begun to raise capex budgets as concerns over EV-derived copper demand rises. Companies are trying to focus on internal projects, which are cheaper than acquiring copper mines given the high assumed copper price associated with acquisitions.

Based on the above changes, we calculate the average copper price required to generate a 17% IRR is US\$7,067/t (USc320/lb, real 2018\$) with a fourth-quartile requirement of > US\$9,000/t (USc4.1/lb, real 2018\$). The exhibit on the next page shows our copper incentive price curve for all GS Copper projects using their respective required IRRs. At the higher end of the cost curve, we see mainly highly capital-intensive greenfield projects, some of which require significant infrastructure beyond the scope of the mining operations, including roads or power stations. These are generally located in riskier jurisdictions requiring a higher acceptable IRR for boards to approve.

Our revised estimate of an average incentive copper price of c.US\$7,067 for the GS Copper projects is c.33% higher than our previous estimate (published in our 2017 *GS Top Copper Projects* report of July 5, 2017).

Exhibit 60: The required copper price for the copper projects we analyse is > US\$7000/t
Incentive price required for new copper projects (US\$/t)

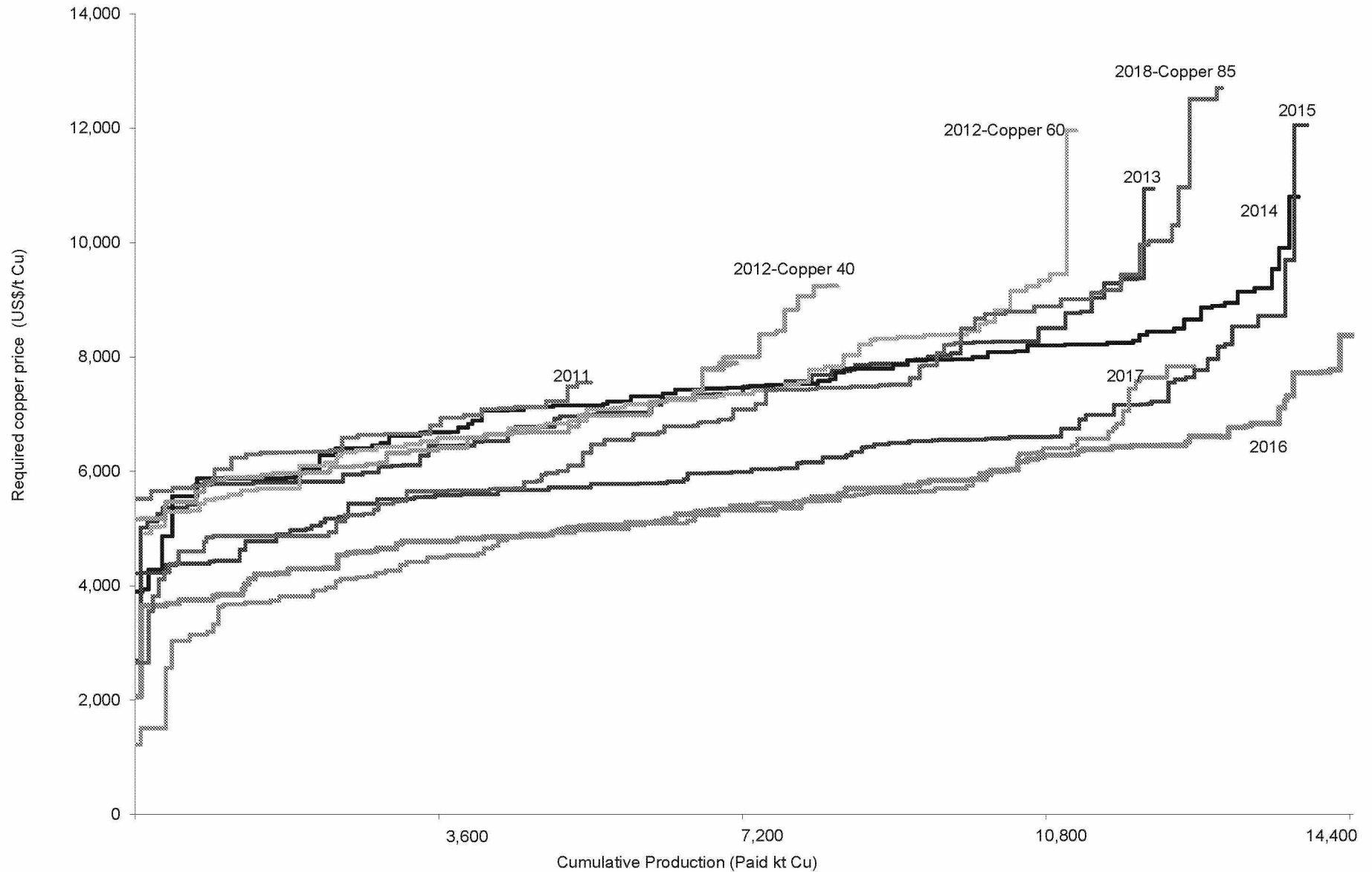


Source: Company data, Goldman Sachs Global Investment Research

Key Changes: Capex and costs rising

A core theme that has developed over the past eight iterations of this report has been deflation. This year, however, attention has turned to inflation as global growth has been stronger, fueling higher inflation and rising yields. This has led to a c.33% yoy incentive price rise in our *GS Top Copper projects 2018* report:

- **Input inflation:** Since the inflection of commodity prices post the China super-cycle, prices of almost all the inputs needed to build a mine (steel, oil etc.) fell significantly. This year, however, stronger global growth driven by the stronger US economy has seen the return of inflation. This can be seen through the prism of labour costs, as mining companies have had to agree to higher wage settlements than they might have expected this time last year.
- **Capex inflation:** Apart from input cost inflation, overall capex has also risen (capex intensity is up 2% yoy and likely faces further upward pressure), as a result of stronger global growth as well as the requirement to build out copper production profiles to meet demand from new sources. In addition, there has been a focus on bringing projects online in stages, which enables a company to use near-term cash flows to fund future developments. We have also seen projects in other commodities being delayed.
- **Cost inflation:** Based on the current increase in costs for miners, evident from the 2Q18 earnings results, we assume cost inflation of 3% in our model, a reversal of our assumption last year of cost deflation of 1% for the first four years and 3% inflation thereafter.
- **FX no longer the support:** The FX tailwind that reversed last year has continued to further solidify into a headwind for the mining companies. While more recently, there has been a material depreciation in producer country FX – mainly led by Turkey concerns – our economists remain constructive on producer country FX.

Exhibit 61: Copper price required for projects to come online has risen after falling for four consecutive years

Source: Company data, Goldman Sachs Global Investment Research

Riskied projects look attractive on spot copper prices

Of the 84 projects we analyse, 33 are riskied and 51 are unapproved. Riskied projects are those that we believe have a high probability of proceeding to construction, as they have been approved by their boards or have seen substantial work already undertaken. Unapproved projects are those that are either yet to be approved, have recently run into environmental issues, or are being re-evaluated in the current copper price environment. For unapproved projects, we continue to see the risk of project deferrals and/ or cancellations, as companies engage in more extended feasibility studies to assess the overall returns of these projects.

The incentive price curves in the exhibit below include all the projects considered in the top projects analysis. However, the economics of riskied projects remain relatively more attractive when compared with unapproved projects. The average incentive price required for riskied projects is US\$6,799/t compared with the average incentive price required for unapproved projects of US\$7,307/t. The exhibit below shows the project economics for riskied and unapproved projects, including any capex that the companies have spent to date.

Exhibit 62: Project economics for riskied projects look more attractive than unapproved projects

Project economics of riskied and unapproved projects including sunk costs

	LOM output	Unit capex (US\$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US\$ mn) GSe	IRR (GSe)	NPV @ 8% (2018+) (US\$ mn) GSe	IRR (GSe) (2018+)	Cu price required @ riskied-IRR
GS Copper Top Projects total	13159 ktpa	\$14,614 /t	\$163,267	14.9%	\$189,408	19.2%	\$7,067 /t
Riskied projects	4308 ktpa	\$13,071 /t	\$84,343	16.2%	\$109,483	32.5%	\$6,799 /t
Unsanctioned projects	8851 ktpa	\$15,409 /t	\$78,924	13.7%	\$79,925	13.8%	\$7,307 /t

Source: Company data, Goldman Sachs Global Investment Research

Of the 33 risked projects in our analysis, there are 23 projects (accounting for a cumulative LOM average of c.3.4mtpa) where some capex has been spent by companies and the mines are either ramping up/beginning to ramp up; the remaining 10 projects (accounting for a cumulative LOM average of c.1.4mt pa) are those where growth capex is yet to be spent.

While we do not see much risk apart from minor production disruptions and slower ramp-up profiles for the projects currently ramping up, we highlight that both Grasberg expansion projects, Cobre Panama and Chuquicamata, are key to determining the amount of supply coming on board in the next few years. Our analysis of average incentive prices, excluding sunk costs for projects in which some capex has been invested, suggests these projects have very attractive NPVs at spot copper prices, and we thus continue to have high confidence that these projects will be delivered.

The exhibit below shows the projects on which some capex has been invested to date. The average incentive price, excluding sunk costs, required for these projects is US\$7,271 (USc3.30/lb, 2018\$ real terms). This compares with US\$5,305/t for the same analysis last year, highlighting the viability of these projects. The average IRR of the projects is 16.4%, including capex already spent, above our average of 14.9% for GS Top Projects analysis, and while the IRR slips to 14.5% ignoring sunk costs, there remains a likelihood of these projects developing.

Exhibit 63: Risked projects with some capex invested look attractive if we ignore sunk costs

Projects where capex has been spent

Project	Owner	Country	Status	Project type	Board approved	Start date	Announced Capex (US\$ mn)	GS Capex (US\$ mn)	Unit capex (US\$ / t) Cu	Unit capex (US\$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US\$ mn)	NPV @ 8% (2018+) (US\$ mn)	Payback (years)	IRR	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost (\$/t)	Total cash cost (c/lb)
<u>Aktogay Phase 2</u>	KAZ Minerals	Kazakhstan	Producing	Brownfield	Yes	2021	\$1,200	\$1,220	\$19,629 /t	\$18,558 /t	\$1,148	\$1,148	5.76	16.1%	16.1%	\$5,692 /t	81 ktpa	62 ktpa	\$3,649 /t	166 c/lb
<u>Asmara</u>	Sichuan R&BMIDC	Eritrea	Permitting	Greenfield	Yes	2021	\$559	\$609	\$26,386 /t	\$12,337 /t	\$668	\$668	6.92	23.1%	23.1%	\$6,932 /t	28 ktpa	23 ktpa	\$1,683 /t	76 c/lb
<u>Aynak</u>	China Metallurgical Group	Afghanistan	Permitting	Greenfield	No	2024	\$4,400	\$4,900	\$15,313 /t	\$15,313 /t	-\$543	-\$543	9.66	5.9%	5.9%	\$12,509 /t	320 ktpa	320 ktpa	\$5,374 /t	244 c/lb
<u>Baimskaya</u>	Baimskaya Mining Comp	Russia	Feasibility	Greenfield	Yes	2024	\$5,500	\$5,600	\$31,206 /t	\$23,156 /t	\$2,350	\$2,381	6.35	12.4%	12.5%	\$5,433 /t	316 ktpa	179 ktpa	\$2,114 /t	96 c/lb
<u>Carrapateena</u>	OZ Minerals	Australia	Construction	Greenfield	Yes	2020	\$687	\$789	\$12,138 /t	\$10,126 /t	\$1,224	\$1,453	4.05	21.3%	31.4%	\$4,233 /t	66 ktpa	65 ktpa	\$3,628 /t	165 c/lb
<u>Casino</u>	Western Copper & Gold	Canada	Permitting	Greenfield	Yes	2023	\$3,345	\$3,545	\$41,357 /t	\$25,365 /t	-\$432	-\$399	11.78	6.7%	6.8%	\$8,069 /t	181 ktpa	86 ktpa	\$4,836 /t	219 c/lb
<u>Chambishi</u>	China Non-Ferrous Metals	Zambia	Construction	Greenfield	Yes	2018	\$700	\$750	\$13,777 /t	\$10,479 /t	\$228	\$408	8.17	13.4%	21.8%	\$6,800 /t	59 ktpa	54 ktpa	\$4,630 /t	210 c/lb
<u>Chuquibambilla U/G</u>	Codelco	Chile	Construction	Brownfield	Yes	2020	\$4,000	\$4,200	\$12,764 /t	\$11,222 /t	\$4,203	\$6,670	9.04	13.2%	24.6%	\$7,482 /t	366 ktpa	329 ktpa	\$4,266 /t	193 c/lb
<u>Cobre Panama</u>	First Quantum	Panama	Construction	Greenfield	Yes	2019	\$6,300	\$6,350	\$20,196 /t	\$19,164 /t	\$3,505	\$8,745	8.59	10.5%	38.7%	\$8,883 /t	334 ktpa	314 ktpa	\$4,021 /t	182 c/lb
<u>El Pilar</u>	Southern Copper	Mexico	Construction	Greenfield	Yes	2019	\$159	\$179	\$5,818 /t	\$5,818 /t	\$409	\$409	3.98	31.6%	31.6%	\$4,765 /t	33 ktpa	31 ktpa	\$4,300 /t	195 c/lb
<u>El Teniente NMM</u>	Codelco	Chile	Construction	Brownfield	Yes	2023	\$5,000	\$5,100	\$12,530 /t	\$11,904 /t	\$3,497	\$4,720	7.35	12.6%	17.2%	\$7,460 /t	434 ktpa	407 ktpa	\$4,567 /t	207 c/lb
<u>Florence Copper</u>	Taseko Mines Ltd.	USA	Construction	Greenfield	Yes	2018	\$200	\$220	\$6,576 /t	\$6,576 /t	\$885	\$905	6.62	32.1%	38.1%	\$4,870 /t	39 ktpa	33 ktpa	\$3,971 /t	180 c/lb
<u>Grasberg BC</u>	Freeport	Indonesia	Construction	Brownfield	Yes	2016	\$6,400	\$6,700	\$27,245 /t	\$20,363 /t	\$5,817	\$9,643	6.91	13.0%	35.0%	\$7,514 /t	429 ktpa	246 ktpa	\$2,346 /t	106 c/lb
<u>Grasberg DMJZ</u>	Freeport	Indonesia	Construction	Brownfield	Yes	2015	\$3,100	\$3,200	\$25,562 /t	\$18,411 /t	\$2,998	\$5,346	9.68	13.3%	47.7%	\$7,180 /t	245 ktpa	125 ktpa	\$2,379 /t	108 c/lb
<u>Jama Phase II</u>	China Gold International	China	Producing	Brownfield	Yes	2017	\$716	\$736	\$7,050 /t	\$5,495 /t	\$3,945	\$4,664	4.78	28.9%	--	\$4,380 /t	110 ktpa	104 ktpa	\$3,234 /t	147 c/lb
<u>Katanga</u>	Glencore	DRC	Construction	Brownfield	Yes	2017	\$1,096	\$1,159	\$4,237 /t	\$1,866 /t	\$17,184	\$17,567	2.05	198.0%	--	-\$1,243 /t	300 ktpa	274 ktpa	\$755 /t	34 c/lb
<u>Lone Star</u>	Freeport	USA	Construction	Greenfield	Yes	2020	\$850	\$900	\$10,992 /t	\$10,992 /t	\$632	\$683	7.87	12.8%	13.5%	\$4,870 /t	89 ktpa	82 ktpa	\$4,906 /t	223 c/lb
<u>Mantoverde</u>	Mantos Copper	Chile	Pre-feasibility	Brownfield	yes	2022	\$800	\$850	\$11,586 /t	\$10,863 /t	\$234	\$234	7.75	11.3%	11.3%	\$4,870 /t	79 ktpa	73 ktpa	\$4,880 /t	221 c/lb
<u>Metalkol</u>	ENRC	DRC	Construction	Greenfield	Yes	2019	\$833	\$900	\$13,514 /t	\$5,764 /t	\$4,884	\$5,608	3.89	30.1%	114.6%	\$3,820 /t	70 ktpa	67 ktpa	\$701 /t	32 c/lb
<u>Mirador</u>	Ecuacorriente S.A	Ecuador	Construction	Greenfield	Yes	2020	\$1,400	\$1,500	\$19,026 /t	\$17,139 /t	\$1,696	\$2,067	6.80	15.5%	20.1%	\$10,303 /t	81 ktpa	79 ktpa	\$3,415 /t	155 c/lb
<u>Mopani</u>	Glencore	Zambia	Construction	Brownfield	Yes	2018	\$950	\$1,025	\$10,807 /t	\$10,757 /t	\$2,126	\$3,161	5.04	19.3%	--	\$5,489 /t	99 ktpa	95 ktpa	\$3,764 /t	171 c/lb
<u>Olympic Dam BFX</u>	BHP Billiton	Australia	Permitting	Brownfield	No	2018	\$2,940	\$3,040	\$18,842 /t	\$17,499 /t	\$6,681	\$6,681	6.97	40%	39.6%	\$2,653 /t	177 ktpa	161 ktpa	\$2,612 /t	118 c/lb
<u>Oyu Tolgoi Block Cave</u>	Rio Tinto	Mongolia	Construction	Brownfield	Yes	2020	\$5,095	\$5,395	\$15,749 /t	\$13,374 /t	\$4,073	\$5,130	7.74	13.9%	17.0%	\$6,791 /t	491 ktpa	343 ktpa	\$3,891 /t	177 c/lb
<u>Puliang</u>	Chinalco	China	Producing	Greenfield	Yes	2017	\$943	\$950	\$17,988 /t	\$16,061 /t	\$174	\$1,194	9.68	9.2%	--	\$8,221 /t	55 ktpa	53 ktpa	\$4,550 /t	206 c/lb
<u>Pumpkin Hollow</u>	Nevada Copper	USA	Construction	Greenfield	Yes	2020	\$1,050	\$1,100	\$12,197 /t	\$10,884 /t	\$1,330	\$1,596	7.28	17.2%	25.0%	\$4,938 /t	125 ktpa	90 ktpa	\$4,415 /t	200 c/lb
<u>Quellaveco</u>	Anglo American	Peru	Construction	Greenfield	Yes	2023	\$5,200	\$5,400	\$22,258 /t	\$20,184 /t	\$1,775	\$1,901	7.82	10.8%	11.0%	\$8,750 /t	313 ktpa	243 ktpa	\$4,527 /t	205 c/lb
<u>Santo Domingo</u>	Capstone Mining	Chile	Feasibility	Greenfield	Yes	2023	\$1,750	\$1,850	\$29,959 /t	\$17,588 /t	\$1,610	\$1,662	5.84	17.2%	17.8%	\$5,476 /t	130 ktpa	62 ktpa	\$1,251 /t	57 c/lb
<u>Sentinel</u>	First Quantum	Zambia	Producing	Greenfield	Yes	2015	\$2,000	\$2,000	\$9,086 /t	\$9,086 /t	\$5,275	\$6,929	5.39	19.7%	--	\$5,239 /t	255 ktpa	220 ktpa	\$4,126 /t	187 c/lb
<u>Spence growth option</u>	BHP Billiton	Chile	Construction	Brownfield	Yes	2021	\$2,460	\$2,510	\$14,492 /t	\$12,933 /t	\$3,851	\$3,851	5.32	18.8%	18.8%	\$5,697 /t	197 ktpa	173 ktpa	\$3,652 /t	166 c/lb
<u>Tia Maria</u>	Southern Copper	Peru	Permitting	Greenfield	Yes	2022	\$1,400	\$1,500	\$13,360 /t	\$13,360 /t	\$1,179	\$1,657	7.12	12.6%	18.8%	\$7,632 /t	120 ktpa	112 ktpa	\$4,041 /t	183 c/lb
<u>Tomnisky</u>	Russian Copper Compar	Russia	Construction	Greenfield	Yes	2018	\$1,183	\$1,283	\$16,042 /t	\$16,042 /t	\$2,058	\$2,375	nm	18.8%	27.9%	\$4,846 /t	105 ktpa	80 ktpa	\$3,479 /t	158 c/lb
<u>Toquesala</u>	Southern Copper	Peru	Construction	Brownfield	Yes	2018	\$1,300	\$1,310	\$13,091 /t	\$12,121 /t	\$2,343	\$3,318	6.00	16.2%	67.2%	\$6,325 /t	103 ktpa	100 ktpa	\$3,829 /t	174 c/lb
<u>Toromocho expansion</u>	Chinalco	Peru	Construction	Brownfield	Yes	2020	\$1,360	\$1,400	\$13,512 /t	\$11,601 /t	\$2,634	\$2,738	5.94	21.2%	23.5%	\$5,130 /t	123 ktpa	104 ktpa	\$3,494 /t	158 c/lb
Total - Risked	-	-	-	-	-	-	\$67,536	\$70,230	\$16,301 /t	\$13,071 /t	\$84,693	\$109,833	7.99	16.3%	32.7%	\$6,799 /t	5,455 ktpa	4,308 ktpa	\$510 /t	23 c/lb

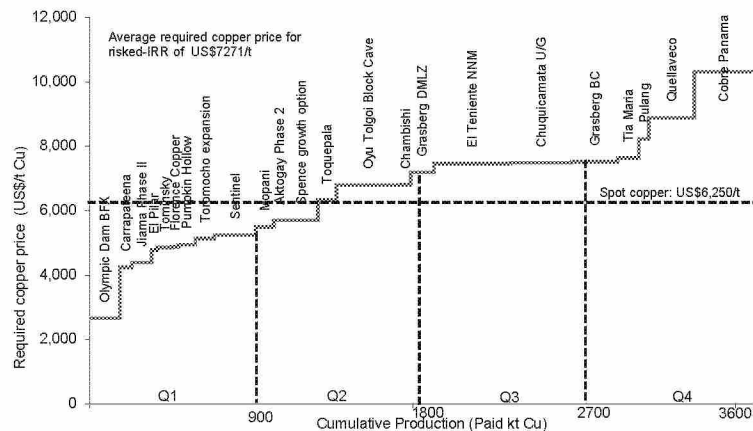
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 64 shows the 23 risky projects in our GS Top Projects copper analysis on which some capex has been spent. Exhibit 65 shows the same projects using the remaining capex figure. This suggests that close to half the projects being considered, including historical capex, would not have been NPV positive at spot prices and would therefore be unlikely to obtain approval. However, given the advanced stages these projects have now reached, with part of the capex having been spent, we estimate almost all projects are economically viable even if copper prices were to fall 14%.

In general, the projects presented in Exhibit 65 vary in terms of capex share already spent, as well as the stability of jurisdictions in which they are based. Accordingly, the curve is for illustrative purposes only, to evaluate the incentive price relative to current spot and long-term assumptions, and not for relative project rankings.

Exhibit 64: At spot copper prices, c.50% of the projects would not have been approved

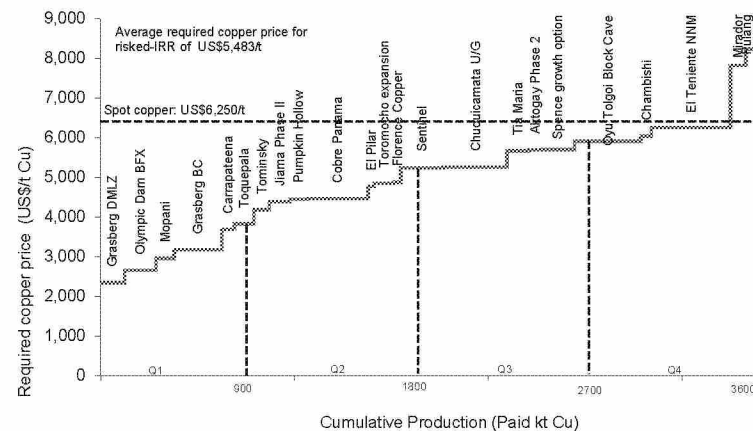
Incentive cost curve for projects where part of capex has been spent including sunk costs



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 65: However, taking sunk costs into consideration, this falls to just three projects (13%)

Incentive cost curve for projects where part of capex has been spent excluding sunk costs



Source: Company data, Goldman Sachs Global Investment Research

Unapproved projects - unviable at current prices

Our analysis consists of 51 unapproved copper projects that are either yet to receive board approvals or have recently run into environmental issues/face a re-evaluation of economics in the current copper price environment. These projects together account for c.8.8 mtpa of LOM average copper production, with start dates of 2020 and beyond. We acknowledge that these projects have relatively weaker project economics than risked projects, with an average required incentive copper price of US\$7,307/t (US\$3.31/lb, 2018\$ real terms). We believe these projects may continue to face challenges, causing delays to initial company plans. These challenges may be in the form of:

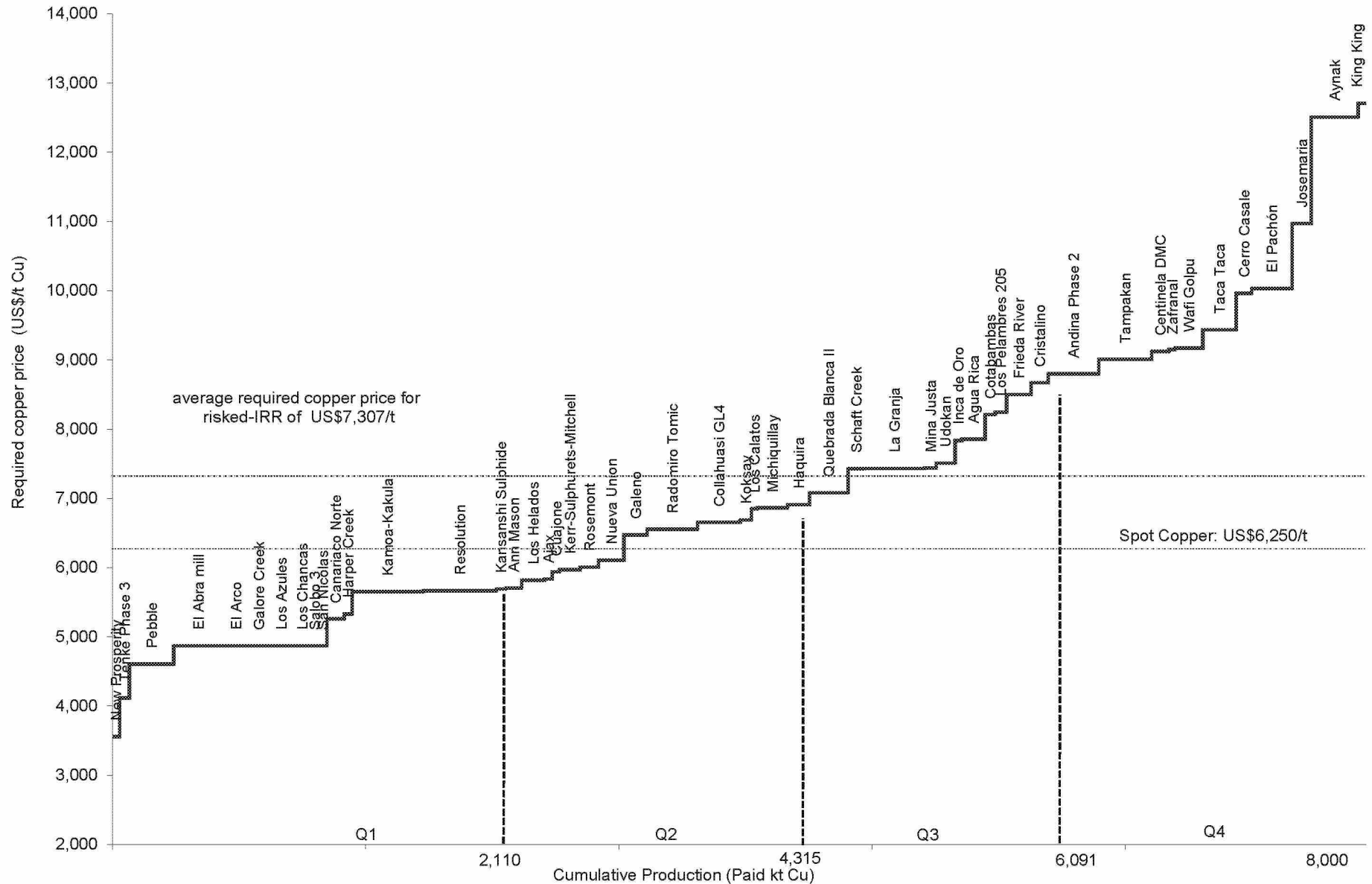
- **Environmental-social, permitting:** The permitting process for new mines or mine expansions is becoming increasingly challenging, both in developed and emerging economies. Issues faced by miners include water and power availability, community relocations and other environmental concerns raised by the localities. Aynak in Afghanistan and Tampakan in the Philippines are examples of projects that have faced issues.
- **Fiscal/sovereign:** This applies more to emerging economies, where a mining code may only be recently implemented and subject to change, or might not be in place at all. Associated issues revolve mainly around taxation, royalties and government ownership. The Oyu Tolgoi mine is a good example of this risk, where discussions with the Mongolian government regarding the Phase 2 development took longer to be resolved than initially estimated. Recent issues in DRC around royalties and the ongoing dispute between the Zambian Revenue Authority and First Quantum are good examples of the continued challenge of mining in EM countries.
- **Changing project economics/more prudent use of capital by miners:** While project economics are looking better than they were over the last couple of years, it is important to note that capex/cost estimates have also increased. Therefore, it might be a misconception that higher prices will result in more projects being given greenlight.

We highlight that our project assumptions are likely more conservative than those used by project owners, particularly in relation to company-guided capex estimates and ramp-up schedules. Following the many announced capex over-runs for recently commissioned projects, or projects currently under construction, we believe it is more prudent to factor in capex inflation within our analysis. As a result, our aggregate capex estimate for the 51 unapproved copper projects is c.US\$161 bn, which compares with company-guided estimates totaling c.US\$150 bn. We believe this to be a fair assessment of the potential upward capex pressure, reflecting the fact that most projects in this list are many years away from commissioning.

The exhibit on the next page shows the incentive price that we believe is required for the unapproved projects.

Exhibit 66: More than 3/4 of the projects are not viable at spot copper prices

Copper Top Projects – Incentive price curve for unapproved projects



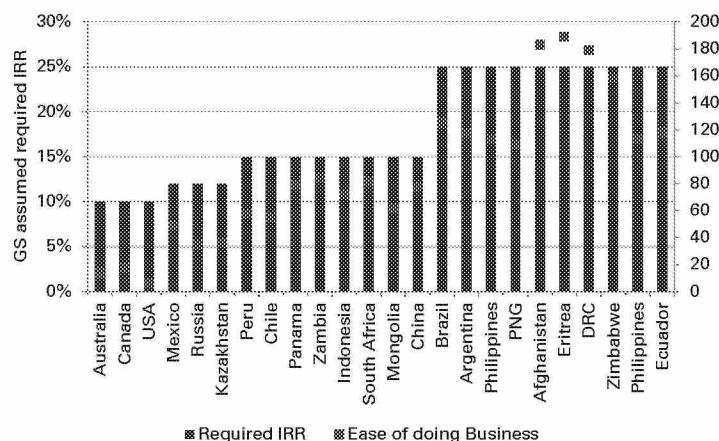
Source: Company data, Goldman Sachs Global Investment Research

Significant production coming from risky jurisdictions, potential +ve for copper

This year, we have changed how we calculate the IRRs in our project analysis. Previously, we used the Frazer scores for each geography, which give an indication of how easy it is to establish/operate a mine in a particular country. However, given the more theoretical nature of these scores, which does not capture the ongoing issues in many geographies (e.g. DRC), we move this year to the Ease of Business score, a metric released by the World Economic Forum. This is a combination of multiple factors that we think provides a better representation of the situation on the ground.

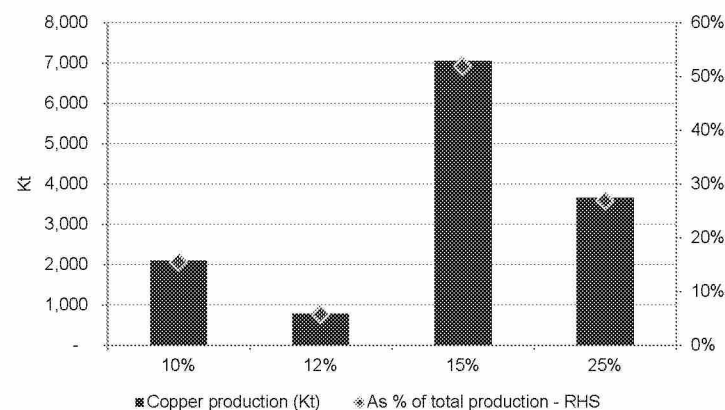
The exhibits below show the required IRR and the score for each country (Exhibit 67), and production weighted by IRR (Exhibit 68), which is a representation of how much production comes from each jurisdiction, risked by the ease of doing business). Worth noting is that c.28% of production growth comes from high-risk jurisdictions such as DRC, Argentina and Afghanistan. We believe a bigger haircut (given the historical disappointment) needs to be applied to production coming from these geographies vs. that from lower-risk jurisdictions.

Exhibit 67: We use the Ease of Doing Business metric to get to the required IRR for each country



Source: World Economic Forum, Goldman Sachs Global Investment Research

Exhibit 68: Significant production coming from risky jurisdictions
Copper production by risk



Source: Company data, Goldman Sachs Global Investment Research

Cobalt - EV demand to continue to see the metal in a deficit

Demand for cobalt will increase as electric vehicles sales rise, given it is a key component of the lithium ion batteries in these cars. In Copper: Top Projects' 2017, we forecast the impact of electric vehicles on cobalt demand by multiplying annual sales of each vehicle type by estimated cobalt content. For this analysis, we start with our Autos team's forecasts for automotive lithium ion batteries, and incorporate a more detailed consideration of the cobalt content in each type of Li-ion battery and how the mix will develop to 2020.

Different Li-ion batteries have similar chemistry, whereby Li-ions discharge from the anode, through an electrolyte, to the cathode. The anode is typically made of graphite, but the cathode contains varying proportions of cobalt, nickel and manganese. Given cobalt is the most expensive metal of the three, and that the cathode represents c.25% of the total cost, the cell cost is very sensitive to Co content. LCO batteries, with a pure cobalt cathode, are therefore too expensive to warrant use in electric vehicles, so the most important batteries are NCAs (mainly Tesla) and NMCs of varying cathode metal ratios. With an aim to lower battery costs, which will be a key facilitator of electric vehicle adoption, battery manufacturers are developing the cells to minimise cobalt content, which we account for in our analysis of demand.

Exhibit 69: Lithium ion batteries consist of five main types, each varying in cobalt content and performance

Criteria	Lithium Cobalt Oxide LCO	Lithium Manganese Oxide LMO	Lithium Iron Phosphate LFP	Nickel Manganese Cobalt NMC	Nickel Cobalt Aluminum NCA
Voltage	3.7V	3.8V	3.3V	3.8V	3.6V
Specific energy (Wh/kg)	150-240	100 - 150	90-120	150-220	200-300
Cycle time	>500	>300	>1000	>1000	>500
Safety	Low	Medium	High	Medium	Low
Cost	High	Low	Medium	Medium-High	Medium
Cathode cobalt content (1)	100%	0%	0%	20%	15%
Areas of application	Electronic devices	Consumer devices / EV	Energy storage / EV	Energy storage / EVs	EV
Used by / in	Portable electronics inc. iPhone	Nissan Leaf / Renault ZOE	Golf carts, electric scooters, home solar	Tesla Powerwall Chevy Volt	Tesla Model S, BMW i3
Pros	High energy density	High operating voltage	Good energy density	Good power / energy density	High energy / density
		High safety (thermal stability)	High Safety	Thermally stable	
Cons	Expensive	Shortened cycle life at higher temperature	Low operating voltage	Moderate cost	Higher cost
	Safety risk		Higher self-discharge	Moderate stability	Low safety
	Low charge / discharge rate	Lower energy density	Limited moisture tolerance	Higher weight / energy	

(1) Cathode typically represents 40% battery weight (2) Based on NMC 622, NMC 811 would lower Co to 10% cathode

Source: Data compiled by Goldman Sachs Global Investment Research

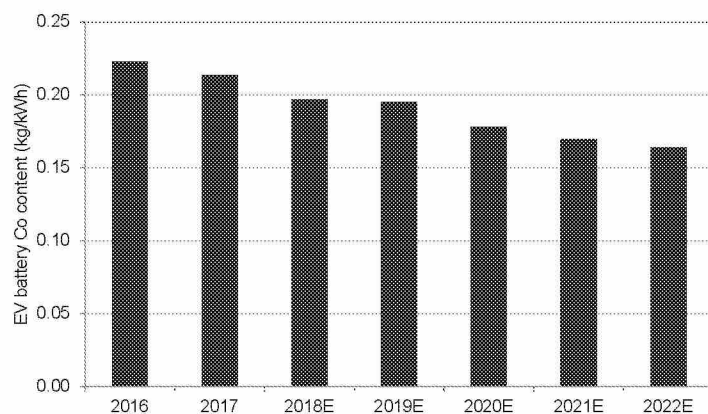
Even as batteries reduce cobalt content, overall metal demand is set to rise

Our analysis is based on lithium ion battery forecasts for automotives generated by our Autos team. By varying the relative overall proportions of each battery type from 2017 to 2022 and factoring in a general shift from higher Co content batteries to lower (e.g. increasing the market share of NMC 811 batteries), our average EV battery Co content decreases from 0.22kg/kWh to 0.13g/kWh across the period.

Assessing the potential future share of each battery type is difficult owing to potentially rapid advances in technology, so we have made rough estimates for how relative proportions of each will change in the future. Tesla has historically been differentiated by its use of NCA batteries. With regard to the NMC batteries used by most other manufacturers, there is a general shift from NMC 111 (equal ratios of Ni, Mn, Co) to NMC 622 in the near term and NMC 811 in the medium to long term. The 811 battery already exists, but its use has not yet spread significantly beyond China given some safety concerns. This is because of the thermal stability Co can provide to nickel, so successfully eliminating cobalt from lithium batteries is likely to be some years away. Our estimates attempt to capture these insights, but a clear risk to our thesis relates to how the technology changes and how fast Co content is reduced, if EVs are to be significant at all over the next four years.

Exhibit 70: Cobalt content in EV batteries to start decreasing with a drive to lower costs

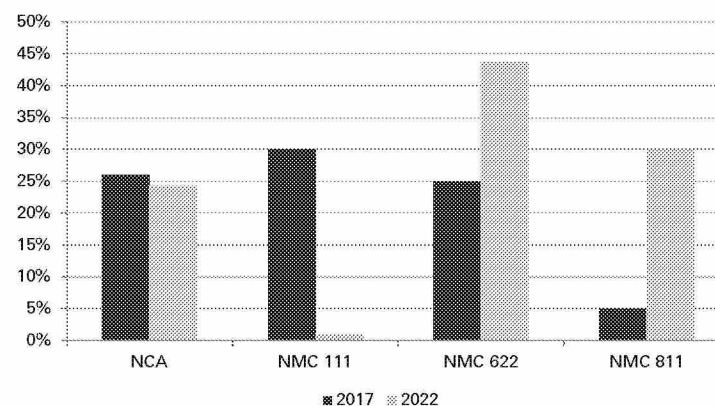
Co content in EV batteries to decrease from 0.22kg/kWh to 0.16kg/kWh from 2016 to 2022



Source: Data compiled by Goldman Sachs Global Investment Research, McKinsey

Exhibit 71: We expect NMC 622 and 811 batteries to capture share from NMC 111s as battery makers reduce cobalt content

Estimates for share of each battery type used in electric vehicles for 2017 and 2022E



Source: Data compiled by Goldman Sachs Global Investment Research

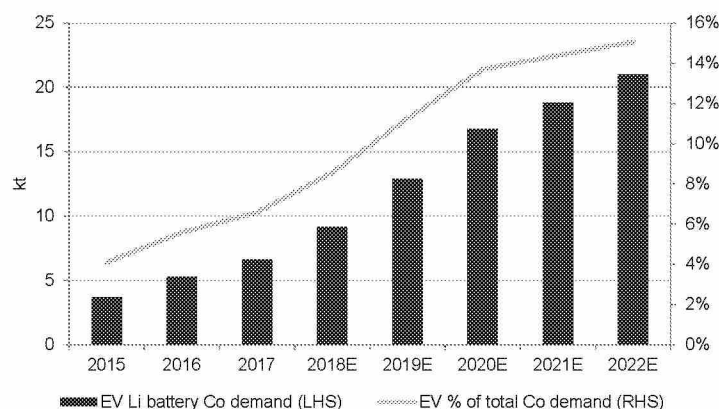
Batteries are supercharging cobalt demand

Combining the cobalt content estimates with forecast EV lithium battery capacity (GWh), we forecast cobalt demand from batteries alone more than tripling from 2017 to 21kt in 2022. Given that this equates to a CAGR of c.33%, we apply an overall CAGR of 6.8% (reflecting EV share of demand) to the total cobalt demand for 2016 to calculate the overall demand expected. The result is c.100kt in 2017 (also indicated by the Cobalt Institute), increasing by almost 40% by 2022. This is lower than other forecasts we have seen, likely a result of more conservative EV forecasts and our incorporation of an expected reduction in Co content per kWh. In summary, regardless of an overall reduction in cobalt content per kWh, EV batteries are growing fast enough to outweigh this, resulting in increasing annual demand overall.

Our analysis is based on our assumption that batteries will be the key driver of future cobalt demand, given that they have historically accounted for 45% of the total. Hence, assuming that all other end-uses of the metal stay roughly constant, cobalt consumption from batteries increases by c.12% yoy such that by 2022E, batteries are responsible for 60% of demand. Again, we may be relatively conservative in our view, given that other estimates surpass 60% by 2020 and that we neglect any exceptional growth in other end-markets. For example, it could be that growth in cobalt demand from superalloys is higher than our forecasts, suggesting jet engines require more new metal as scrap supply is insufficient.

Exhibit 72: Lithium batteries from EVs will demand 21kt of cobalt in 2022, representing double the share of total demand last year

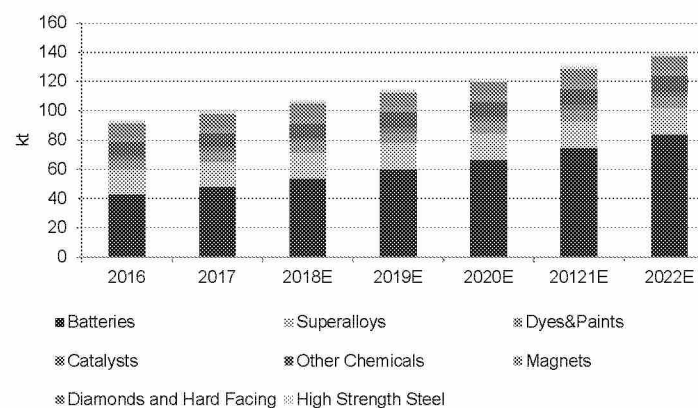
Cobalt demand in kilo-tonnes to reach 15% of total demand by 2022E



Source: Goldman Sachs Global Investment Research

Exhibit 73: Batteries for EVs and devices combined likely to be the key driver of cobalt demand growth over the next few years

Cobalt demand forecasts by end-market in kilo-tonnes



Devices include portable electronics, medical equipment, energy storage etc.

Source: Data compiled by Goldman Sachs Global Investment Research

Exhibit 74: Cobalt S-D Model

GLOBAL COBALT INDUSTRY ANALYSIS
SUPPLY AND DEMAND MODEL

Supply											
Cobalt mine production ('000 tonnes)	2012	2013	2014	2015	2016	2017	2018E	2019E	2020E	2021E	2022E
Democratic Republic of the Congo											
Tenke Fungurume	11.8	11.7	12.8	16.0	16.1	16.4	16.2	16.2	16.2	16.2	16.2
Katanga	2.1	2.3	2.8	2.9	-	-	11.0	28.0	30.0	30.0	30.0
Mutanda/Comide	8.5	13.7	14.4	16.5	24.5	23.9	24.2	24.8	24.8	24.8	24.8
Mukondo Mountain	9.6	9.7	8.5	9.5	4.8	7.1	7.1	7.1	7.1	7.1	7.1
Big Hill (STL)	4.0	4.3	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Etoile Mine	1.3	1.2	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ruashi	3.0	3.0	3.9	4.3	3.3	3.8	3.8	3.8	3.8	3.8	3.8
Other DRC	11.7	12.1	17.7	14.1	9.4	16.7	16.7	16.7	16.7	16.7	16.7
Total DRC	52.0	58.0	66.9	69.3	64.0	73.9	85.1	102.7	104.7	104.7	104.7
Rest of the world											
Murrin Murrin	2.5	2.6	2.8	2.8	2.8	2.8	2.7	2.6	2.6	2.6	2.6
Mopani	0.3	-	-	-	-	-	-	-	-	-	-
Sudbury	0.6	0.9	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.9	0.9
Voisey's Bay	1.2	1.3	1.0	0.8	0.9	1.8	1.4	1.4	1.4	1.4	1.4
VNC	0.4	1.1	1.4	2.4	3.2	2.8	3.0	3.0	3.0	3.0	3.0
Thompson	0.1	0.3	0.5	0.4	0.7	0.1	0.4	0.4	0.4	0.4	0.4
Others	45.9	55.9	49.6	49.5	38.5	27.7	33.1	33.1	33.1	33.1	33.1
Global cobalt mine production ('000 tonnes)	103.0	120.0	123.0	126.0	111.0	110.0	126.5	144.0	146.0	146.0	146.0
yoy %	-6%	17%	2%	2%	-12%	-1%	15%	14%	1%	0%	0%
Refined cobalt production ('000 tonnes) @ 75% conversion	77.3	90.0	92.3	94.5	83.3	82.5	94.9	108.0	109.5	109.5	109.5
yoy %	-6%	17%	2%	2%	-12%	-1%	15%	14%	1%	0%	0%
Demand ('000 tonnes)											
Batteries	30.6	32.9	39.1	41.1	43.1	48.2	53.8	60.0	66.7	75.1	84.0
% Total	41%	41%	45%	45%	46%	48%	50%	52%	55%	57%	60%
Superalloys	13.1	14.6	15.8	16.3	16.8	17.3	17.5	17.7	18.0	18.0	18.0
% Total	18%	18%	18%	18%	18%	17%	16%	15%	15%	14%	13%
Dyes&Paints	6.2	6.4	6.6	6.6	6.8	7.0	7.2	7.5	7.7	7.7	7.7
% Total	8%	8%	7%	7%	7%	7%	7%	7%	6%	6%	6%
Catalysts	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.4	3.4	3.4
% Total	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%
Other Chemicals	8.0	8.4	8.9	9.0	9.3	9.7	10.1	10.4	10.8	10.8	10.8
% Total	11%	11%	10%	10%	10%	10%	9%	9%	9%	8%	8%
Magnets	3.6	3.4	3.5	3.5	3.6	3.7	3.7	3.8	3.8	3.8	3.8
% Total	5%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%
Diamonds and Hard Facing	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.7	9.7
% Total	12%	12%	10%	10%	10%	9%	9%	8%	8%	7%	7%
High Strength Steel	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8
% Total	2%	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Global apparent demand ('000 tonnes)	74.9	79.4	87.7	90.6	94.0	100.4	107.2	114.5	122.3	130.6	139.5
yoy %		6%	10%	3%	4%	7%	7%	7%	7%	7%	7%
Supply surplus/(deficit) ('000 tonnes)	2	11	5	4	-11	-18	-12	-6	-13	-21	-30

Source: USGS, Reuters, Wood Mackenzie, Company data, Goldman Sachs Global Investment Research

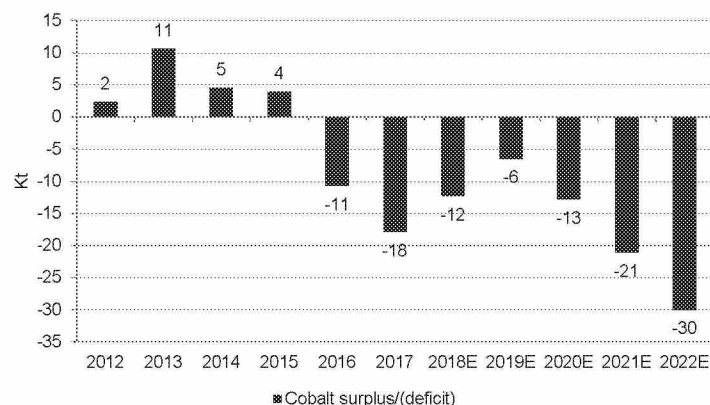
Cobalt bull-bear case: Battery safety concerns to likely impede aggressive substitution

Although other end markets represent a significant portion of cobalt demand, the biggest consumer remains batteries, which currently account for c.50% of cobalt demand. In line with our base case forecasts, we assume this grows to account for 60% of demand by 2022.

For our bull and bear analysis, we maintain our Autos team's base case for EV uptake, with the variable factor being the rate of substitution of cobalt in EV batteries. We have adjusted the relative share of each battery type in line with our views on changes in battery composition; in summary, we expect **increasing battery demand with decreasing amounts of cobalt**. In our bull case, we assume a slower substitution of cobalt in batteries (relative to our base case). However, for the bear case, we have adjusted for a relatively accelerated uptick in material substitution resulting in a lower cobalt content per battery and subsequently lower demand.

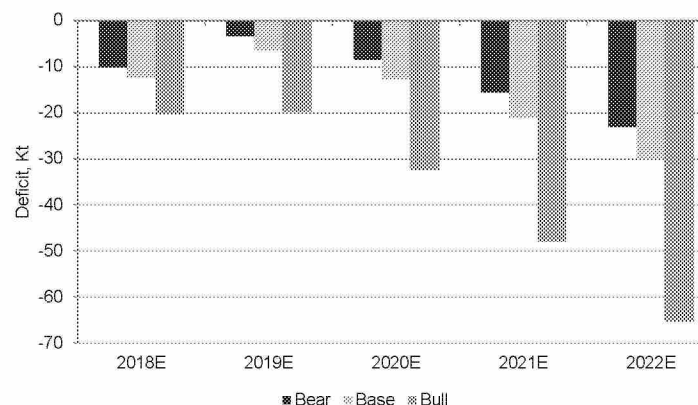
Exhibit 76 shows the wide range of outcomes depending on the rate of cobalt substitution as evidenced by our 2022E deficit, which lies between -23kt for our bear case and -65kt for our bull case. We maintain our base case as a more likely scenario, as battery compositions will likely stay constant to maintain vehicle safety standards.

Exhibit 75: Cobalt S-D balance to remain in deficit as demand (mainly from EV batteries) outpaces supply...



Source: USGS, Reuters, Wood Mackenzie, Company data, Goldman Sachs Global Investment Research

Exhibit 76: ...however, cobalt substitution in batteries will be the main determinant of how big or small this supply deficit is



Source: Wood Mackenzie, Goldman Sachs Global Investment Research

Company Profiles

BHP Billiton (BLT.L/BHP.AX): Returns to accelerate after onshore shale sale; remain Buy

We remain Buy rated on BHP (BLT.L / BHP.AX) with 12-month price targets of GBp1,950/A\$40.

Very strong copper portfolio; Escondida strike averted

BHP has a strong copper portfolio and is the largest copper producer in our coverage. The company is in the process of increasing production at two of its mines: (1) Spence Hypogene; and (2) Olympic Dam. The Spence growth option was approved last year for total capex of US\$2.5 bn + the US\$1.43 bn to be spent over 20 years – BHP has outsourced the building of the desalination plant. The expansion at Olympic Dam has been more difficult, and BHP has continued to struggle to keep production steady with different issues affecting the overall production. While we take into account the growth optionality at the mine, where the company is planning to add c.160Kt (for capex of US\$3 bn, on our estimates), we highlight that risks from this mine are likely skewed to the downside. BHP averted the Escondida strike in August by reaching a last-minute deal with workers. While the details of the offer are not public, we believe it was likely higher than that made before the government-mediated talks. While the lack of disruption had a negative short-term effect on copper prices, the inflationary impact of the deal is positive for copper prices longer term.

Lack of catalysts, but still see material value; valuation remains attractive

Our upgrade of BHP on April 15 was predicated on: (1) strong cash conversion in 2H18 vs. 1H18; (2) strong returns, with the FY18 results; and (3) attractive valuation, both absolute and vs. RIO. Another catalyst was the divestment of the onshore oil assets, for which we estimate a value of US\$7-US\$14 bn. BHP announced recently that it had reached a deal to sell the assets for US\$10.8 bn (note that we take no view on the transaction). While most of the catalysts for BHP have materialised, we remain Buy-rated on the stock as we see material value; BHP continues to trade at a 7% discount to RIO vs. a historical premium of 2% on 12-month-forward consensus EV/EBITDA (I/B/E/S).

Valuation and key risks

We are Buy rated on BLT.L/BHP.AX and value it on 6.5x (50/50 FY19/FY20E) EBITDA to derive our 12-month price targets of 1,950p and A\$40 (previously 2,000p/A\$42). Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX. Our EPS estimates rise despite the fall in EBITDA on account of lower tax.

Key risks include: (1) operational issues, especially at the iron ore operations given their importance to FCF generation; (2) a potential asset swap for the onshore assets – this would imply no cash in, which could disappoint investors, in our view; and (3) a significant slowdown in China, which would likely affect demand for key commodities in BHP's portfolio.

Rio Tinto (RIO.L / RIO.AX): M&A likely ahead as growth in copper sought; remain Neutral

We remain Neutral rated on Rio Tinto (RIO.L / RIO.AX) with 12-month price targets of GBp4,000/A\$82.

Focus on copper but no immediate growth projects; M&A likely

Copper is a small part of RIO's earnings profile: as of 2018, we expect copper to contribute <15% to the company's EBITDA. While Rio has a couple of growth projects – the one in the near term being the Oyu Tolgoi underground expansion – the company does not have any other approved growth projects in the pipeline. The other projects, Resolution and La Granja, are too far away to affect investor investment decisions currently, in our view. Given that the company has been vocal about increasing its exposure in copper (note that its expected copper exposure has come down after the sale of its Grasberg stake), we believe the most likely way it would achieve this is through M&A.

Remains a call on iron-ore prices; other commodities too small to move the dial

Rio Tinto has remained a straight call on iron-ore prices as its exposure to the commodity has increased. RIO's focus has been on selling "non-core" assets, which have included high-cost aluminium assets, all of the coal assets and more recently the stake in the Grasberg mine. This has seen the contribution of iron ore to RIO's EBITDA increase to >60% as of 2018, the highest in our coverage. While we see downside to iron-ore prices in the near term, we believe that the company's focus on returns is likely to support the share price in the near term.

Valuation and key risks

We value RIO on an unchanged 6x 50/50 2018/19E EV/EBITDA. Our 12-month price targets are 4,000p/A\$82 (previously 4,000p/A\$84). Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX.

Higher/lower iron ore prices, FX, and political and fiscal uncertainty are the key risks to our investment thesis. We are Neutral rated.

Anglo American (AAL.L): Growth ahead, valuation undemanding; Buy (on CL)

We remain Buy rated on Anglo American, with a 12-month price target of Gbp2,200. The stock is on our Conviction List.

Quellaveco - the first Greenfield project approved in a long time

With its 1H18 results, Anglo American approved the Quellaveco mine, which is the first greenfield mine approved since the commodity downturn started in 2014. Capex was c.US\$5-US\$5.3 bn and production is expected to be c.300Ktpa. This computes to a capex intensity of c.US\$22,250/t vs. an average of US\$17,750/t for the Quellaveco mine. The reason for this higher capex intensity is that our analysis also includes a significant number of brownfield expansions, where the capex intensity is obviously lower. The company expects the costs to be c.US\$1.05/lb of copper production (real terms). This is an improvement over the guidance that was given previously. Capex is expected to be limited to 1H19 as the company utilises the cash in from Mitsubishi.

Copper to become an increasingly important part of Anglo's earnings driver; other commodity mix favourable too

As of FY17, copper contributed c.17% to Anglo's EBITDA. However, we forecast this number to increase steadily to c.35% by FY2020 on account of higher copper prices and production. The main production increase comes from the improvement in Los Bronces – we forecast production to increase from c.310Kt in 2017 to c.370Kt in 2019. We expect flat production from the remaining mines – note that Quellaveco does not come online until FY23, on our estimates.

More broadly, we remain positive on Anglo's commodity mix: (1) the iron-ore portfolio remains strong, especially given that the lump premium has continued to strengthen amid higher demand from Chinese steel mills; and (2) Met coal also remains strong as the Chinese mills continue to buy higher-quality coking coal; the bid to reduce pollution should be a positive for both the lump premium and coking coal.

Valuation and key risks

We maintain our Buy rating (on CL) on Anglo. We value the shares at 5x (previously 4.5x) 50/50 2018/19E EV/EBITDA, driving a 12-month price target of 2,200p (previously 2,000p). We increase our multiple to reflect the increased contribution of copper – one of our preferred commodities – in the company's earnings. Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX.

Key risks to our view include lower commodity prices, stronger FX and political risk associated with changes in the South African mining charter.

Glencore (GLEN.L): Strong growth ahead; remain Buy despite uncertainties

We remain Buy rated on Glencore with a 12-month price target of GBp400.

High-quality copper portfolio; material growth ahead

Glencore has one of the strongest and the most diverse copper portfolios in our coverage. GLEN produced c.1.3 mn tonnes of copper in FY17 and is in the process of ramping up production from two of its mines in Africa – Katanga in DRC and Mopani in Zambia. On our estimate, the mines could add a further c.200Kt this year and upwards of 350Kt next year to GLEN's production profile, taking its total production to over 1.5 mn tonnes by FY2020. Note that as copper volumes ramp up, the cobalt production from GLEN's mines is also set to increase; we expect total cobalt production to increase to c.60Kt by FY20.

Growing volumes (both copper and cobalt), coupled with our positive view on the commodities, should make copper an increasingly important part of GLEN's earnings. We forecast the contribution to increase from c.30% this year to >45% by FY2020.

Investment thesis - DoJ investigation a risk, but we see risks as more than priced in

GLEN remains one of the best positioned stocks in our coverage given its strong balance sheet and attractive growth projects (both in copper, as discussed earlier, and zinc). This balance sheet strength combined with a lack of growth projects in the pipeline (the capex on the growth projects has either been spent or is in the last stages) means that Glencore can focus on investor returns – dividends + buy-backs – which we believe should remain supportive of the share price.

While there are some uncertainties around the investment case owing to the ongoing DoJ investigation, we highlight that the company's fundamentals remain strong and valuation attractive. With a material volume ramp-up ahead, we forecast earnings momentum remaining strong over the next few halves.

Valuation and key risks

We value Glencore on a SOTP, which values the industrial assets at 4x 2018E EV/EBITDA and the marketing division at 15x 2018E P/E, and mark to market the listed entities. We increase our multiple from 3.5x to 4x to reflect the FCF generation capacity of the business. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our 12-month price target increases from 375p to 400p.

Key risks to our price target and thesis are: (1) uncertainty relating to the ongoing DoJ investigation; (2) lower commodity prices; (3) political and fiscal risks; and (4) FX volatility.

Norilsk Nickel (NKELyq.L): Well-balanced basket of late cycle commodities; Buy

We remain Buy rated on Nornickel (CEEMEA Focus List), with a 12-month price target of US\$24.0.

Copper - 30% of metals basket, key growth project is ramping up

Nornickel enjoys a well-balanced metals exposure, with c.1/3 of revenue coming broadly equally from nickel, copper and PGMs. Nornickel produces c.400kt of Cu pa and expects to increase output further as it has recently launched (hot commissioning started in November 2017) its key growth copper project Bystrinsky GOK, with 70-75kt of Cu and 250-260koz Au output at full ramp-up expected by 2021. Nornickel accounts for c.2% of global copper production, with all mining and processing assets located in Russia.

Investment thesis intact - undervalued play on late-cycle commodities

Norilsk Nickel is the world's largest producer of palladium and one of the largest producers of nickel, platinum, and copper. We believe the market still overlooks the extent to which the company's FCF generation is benefiting from a weakening ruble and a positive outlook on its key metals prices. We see scope for the inflection in FCF to drive a reduction in leverage and support shareholder distributions: we forecast ND/EBITDA to halve by end 2019 to 1.1x (2.1x in 2017), and believe the company will be able to deliver high and growing shareholder returns under different scenarios of dividend payout. We are c.10% ahead of Bloomberg 2019 EBITDA consensus mainly owing to our higher outlook for the nickel price deck. The shares trade at a 2019E dividend yield of 14% (vs. mid cycle of 7.5%) and 2019E EV/EBITDA of 5.3x (vs. mid cycle of 6.2x).

Valuation and key risks

We are Buy rated on Norilsk Nickel (on CEEMEA Focus List). Our 12m PT of US\$24.0 (down from US\$25.0 on our updated copper price deck) is based on a target multiple of 7.3x (a c.10% premium to Nornickel's past five-year average multiple) applied to 2018-19E EBITDA (methodology unchanged). Key downside risks to our view and price target include a stronger-than-expected ruble, weaker-than-expected commodity prices, cost and capex overruns, value-destructive acquisitions/divestments, and changes in shareholding structure leading to changes in cash allocation and development strategy.

Antofagasta (ANTO.L): High capex intensity growth to keep FCF suppressed; down to Sell

We downgrade Antofagasta to Sell from Neutral with a reduced 12-month price target of 725p.

Los Pelambres/Centinela expansion to suppress FCF generation

Antofagasta is in the process of evaluating the Los Pelambres and Centinela expansion plans. For Los Pelambres, the capex is likely to be US\$1.8 bn (US\$1.95 including our assumed capex escalations); we expect first production in 2020 and the mine reaching full capacity of c.100kt by FY2023. Note that this is likely to be implemented in two stages: a c.55Ktpa expansion that is likely to start next year, and the 35ktpa expansion due to start in 2021/22. At Centinela, the company is still evaluating whether to build a new concentrator (adding capacity of 90Ktpd) or to modify the existing one (which adds capacity of 60Ktpd). While a decision has not been taken, we believe it is likely to choose the 90Ktpd option given that the company has the balance sheet power.

It is worth noting that both these projects feature in the fourth quartile of the projects we have analysed. The capex intensity for the projects is > US\$23,000/t, significantly higher than the average of US\$17,450/t.

Grade tick-up likely to see production move up; we see risks to production guidance for FY18

In the near to medium term, lower grade has led to production disappointing in 1H18. The company has guided to a material pick-up in grade, particularly at the Centinela mine, which should see a significant ramp-up in 2H18. While we forecast a production uplift of c.20% HoH, we still expect the company to miss its FY18 guidance: Anto's FY18 guidance is 705-740Kt vs. our forecast of 700Kt. Any slippage here is likely to mean that the company misses on its FY18 guidance and would be a negative catalyst. Note that the production data from Chilean Copper Association showed a continued decline in production at both Los Pelambres and Centinela in July, which means that the uplift required in the remaining months is even higher.

Valuation and key risks

We value Anto on a 5.5x (previously 5x) 50/50 2018/19E EV/EBITDA to derive our 12-month price target of 725p (previously 800p), and downgrade the stock to Sell. We increase our target multiple to reflect mid-cycle earnings vs. peak earnings as was implied by our copper price assumptions previously. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our price target implies downside of 18% vs. average upside of 15% for our coverage. Our 2019 EBITDA estimate is c.10% below StarMine SmartEstimates consensus (Thomson Reuters).

Key risks to our view and price target include higher/lower copper prices than we expect, a weaker/stronger Chilean peso and stronger/weaker operational performance than we forecast. The key near-term risk relates to the guidance cut that we expect the company to announce with the 3Q results. If the company is able to ramp up production at Los-Pelambres/Centinela, this would be a material risk to our thesis.

What would make us more positive: To be more positive, we would need to see the company: (1) move down the cost curve; (2) improve production to reach the guidance; and (3) improve the economics of the brownfield project.

Exhibit 77: Antofagasta key financials

Antofagasta Plc		Ticker Market Cap & EV Free Float Year End		ANTO.L US\$11,275mn 35% December		US\$13,952mn		Price as at close on 03 Oct 18 12-month Price Target Upside/ (Downside) Rating		GBP 879 GBP 725 -18% Sell		Analyst #1 Email Analyst #2 Email		Eugene King eugene.king@gs.com Abhinandan Agarwal abhinandan.agarwal@gs.com	
Production		2016	2017	2018E	2019E	2020E	2021E	Picks & Losses (USD mn)		2016	2017	2018E	2019E	2020E	2021E
Copper (kt)		709	704	702	775	774	814	Sales		3,622	4,749	4,477	5,397	5,706	6,125
Los Pelambres		355	344	345	357	358	385	Operating Costs		-2,100	-2,320	-2,635	-2,873	-2,944	-3,191
Centinela concentrates		180	164	144	194	192	205	EBITDA		1,522	2,430	1,841	2,523	2,762	2,934
Zaldívar (Attr.)		52	52	52	56	56	56	D&A		-578	-581	-682	-710	-707	-662
Centinela cathodes		56	65	89	92	91	92	EBIT		943	1,849	1,159	1,813	2,055	2,272
Michilla		0	0	0	0	0	0	Net finance costs		-59	-68	-63	-53	-47	-55
Antucoya		66	80	71	76	77	76	Others		30	51	-64	-66	-65	-66
Enceentro Oxides		0	0	0	0	0	0	Underlying pre-tax profit		914	1,832	1,032	1,694	1,943	2,151
Molybdenum (kt)		7	11	12	12	12	13	Income tax		-314	-634	-344	-567	-650	-720
Gold (koz)		271	212	182	194	192	205	Tax rate (%)		34%	35%	33%	33%	33%	33%
Silver (koz)		3,799	3,368	2,888	3,099	3,095	3,324	Minorities		-221	-447	-304	-339	-378	-402
Transport (kt)		6,496	6,085	6,419	6,244	6,244	6,244	Underlying net profit		363	750	383	788	915	1,030
								Underlying EPS (USD)		0.37	0.76	0.39	0.80	0.93	1.04
Assumptions (year end)		2016	2017	2018E	2019E	2020E	2021E	Extraordinaries		-222	1	0	0	0	0
Copper (US\$/t)		4,870	6,170	6,555	6,875	7,000	7,100	Reported net profit		141	751	383	788	915	1,030
Copper (US\$/lb)		221	280	297	312	318	322	Reported EPS (USD)		0.14	0.76	0.39	0.80	0.93	1.04
Copper TC/RC Charges (US\$/t)		550	523	495	424	424	424	Shares outstanding (mn)		986	986	986	986	986	986
Molybdenum (US\$/t)		14,024	15,518	22,858	20,000	20,000	20,000	DPS (USD)		0.18	0.51	0.15	0.30	0.35	0.39
Gold (US\$/oz)		1,248	1,258	1,262	1,288	1,350	1,450	Dividend payout ratio (%)		129%	67%	37%	38%	38%	38%
Silver (US\$/oz)		1,714	1,706	1,219	1,717	1,929	2,231								
CLP/US\$		875	649	634	635	650	650	Cash flow analysis (USD mn)		2016	2017	2018E	2019E	2020E	2021E
US\$/GBP		1.36	1.29	1.34	1.30	1.30	1.30	Cash flow from operations		1,013	2,190	1,218	1,658	1,973	2,014
								Capex		-1,009	-1,002	-963	-1,320	-1,520	-2,220
Revenue by Division (%)		2016	2017	2018E	2019E	2020E	2021E	Free cash flow		3	1,189	255	338	453	-206
Los Pelambres		51%	51%	52%	47%	47%	48%	Others		-51	-574	-347	-203	-330	-353
Centinela		37%	35%	34%	41%	40%	40%	Surplus/ (Deficit)		-48	615	-92	135	123	-559
Michilla		0%	0%	0%	0%	0%	0%								
Antucoya		8%	11%	10%	10%	0%	0%	Balance sheet (USD mn)		2016	2017	2018E	2019E	2020E	2021E
Enceentro Oxides		0%	0%	0%	0%	9%	9%	Cash		2,049	2,252	1,846	1,646	1,646	1,646
Centinela DMC		0%	0%	0%	0%	0%	0%	Other Current Assets		1,387	1,378	1,223	1,512	1,558	1,709
Transport		4%	4%	4%	3%	0%	0%	Total current assets		3,435	3,630	2,868	3,158	3,204	3,355
Water		0%	0%	0%	0%	3%	3%	Net fixed assets		8,738	9,064	9,335	9,944	10,758	12,315
								Other long-term assets		1,551	1,515	1,491	1,491	1,491	1,491
EBITDA by Division (%)		2016	2017	2018E	2019E	2020E	2021E	Total assets		13,724	14,210	13,695	14,593	15,452	17,162
Los Pelambres		922	1428	1307	1495	1656	1792	Short-term debt		837	754	562	562	562	562
Centinela		563	859	480	914	984	1019	Other Current Liabilities		717	809	640	752	775	850
Zaldívar		85	134	65	58	59	58	Total current liabilities		1,554	1,562	1,202	1,314	1,337	1,412
Michilla		0	0	0	0	0	0	Long-term debt		2,283	1,955	1,632	1,497	1,375	1,934
Antucoya		65	207	159	226	227	225	Other long-term liabilities		1,377	1,551	1,489	1,489	1,489	1,489
Enceentro Oxides		0	0	0	0	0	0	Total liabilities		5,214	5,068	4,323	4,300	4,200	4,835
Centinela DMC		0	0	0	0	0	0								
Transport		73	75	87	65	71	74	Total common equity		6,815	7,318	7,243	7,826	8,407	9,080
Corporate & Exploration		-101	-141	-152	-176	-176	-176	Minority interest		1,694	1,823	2,126	2,467	2,845	3,247
								Total liabilities & equity		13,724	14,210	13,695	14,593	15,452	17,162
Production Costs (USD/t)		2016	2017	2018E	2019E	2020E	2021E								
Weighted avg gross costs (pre by-products)		156	164	182	177	182	188	Total Debt		3,120	2,709	2,194	2,060	1,937	2,496
Weighted avg net costs (post by-products)		123	124	143	141	146	149	Net Debt		1,072	456	548	414	291	850
								Net debt/ EBITDA		0.7x	0.2x	0.3x	0.2x	0.1x	0.3x
Valuation (x)		2016	2017	2018E	2019E	2020E	2021E	Capital Employed		11,630	11,850	11,566	12,353	13,189	14,823
Share price (GBP)		879	879	879	879	879	879								
Market Cap (USD mn)		11,746	11,174	11,598	11,265	11,265	11,265	Ratios		2016	2017	2018E	2019E	2020E	2021E
EV (USD mn)		9,464	13,455	13,952	14,156	14,411	15,372	CROCI (%)		8%	13%	7%	10%	10%	10%
EV/EBITDA - (attrib. EBITDA)		5.9x	5.2x	7.3x	5.5x	5.1x	5.1x	Net debt / equity		13%	5%	6%	4%	3%	7%
PE		18.5x	14.9x	29.4x	14.3x	12.3x	11.0x	ROIC (%)		5%	10%	7%	10%	11%	11%
Dividend yield (%)		2%	4%	1%	3%	3%	3%	ROA (%)		3%	5%	3%	5%	6%	6%
FCF yield (%)		0%	11%	2%	3%	4%	-2%	ROCE (%)		3%	6%	3%	6%	7%	7%
EV/GCI		0.6x	0.8x	0.8x	0.7x	0.7x	0.7x	ROE (%)		4%	8%	4%	8%	8%	8%
Price/book		1.4x	1.2x	1.2x	1.1x	1.0x	0.9x	Gearing (%)		14%	6%	7%	5%	3%	9%

Source: Company data, Goldman Sachs Global Investment Research

Boliden (BOL.ST): Remain Neutral on lack of catalysts

We remain Neutral rated on Boliden (BOL.ST) with a 12-month price target of Skr250.

A smelter more than a miner, with falling production profile

Boliden owns both mines and smelters with exposure to zinc and copper. On our estimates, activities related to the extraction and refining of copper account for c.40%-45% of Boliden's earnings. Overall, Boliden's smelting capacity in both zinc and copper exceeds its mine production, which leaves the company exposed to the concentrate market. In copper specifically, Boliden currently has a smelting capacity of c.380kt while we estimate its FY18 mine zinc in concentrate production to be around 112kt. In addition, Boliden faces a falling production profile owing to falling copper grades at its Aitik mine and the potential depletion of its Kylahti mine by 2020E. Hence, investment in exploration/external growth is likely required to maintain an integrated business model in copper.

Remain Neutral on the stock given lack of catalysts

Our pricing deck, in the absence of any material growth drivers, implies a rolling over in Boliden's returns and cash generation from recent highs. Following the recent sell-off in the shares, Boliden trades c.10% below the sector average. However, our Neutral view on the stock reflects a lack of clear catalysts in the near term.

Valuation and key risks

We value Boliden using a 5.5x EV/EBITDA multiple applied to our 2018 estimate to derive a 12-month price target of Skr250 (unchanged). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our price target is unchanged on account of lower net debt.

Key risks are higher/lower commodity prices, a further deterioration in smelting terms/improvement above our expectations, and a strengthening/weakening Skr vs. the USD.

First Quantum (FM.TO): Cobre targets likely to be revised but doesn't change our investment thesis; remain Buy

We are Buy rated on First Quantum with a 12-month price target of C\$18.

Cobre Panama coming online next year, albeit at a lower level

We continue to expect Cobre Panama to coming online in 2019. However, we believe that the current guidance of c.150Kt for 2019 is on the optimistic side, and forecast lower volumes of c.100kt for next year. This reflects reason the significant construction work still required to be done at the mine, as a result of which we believe that the production targets are likely to be reset. However, we do not believe that the resetting of the target would be a material negative for the shares as most investors we have spoken to believe the 2019 target is optimistic.

Sentinel still growing, capex decision on Kansanshi to be taken soon

From the existing portfolio, First Quantum still has some growth left, mostly from Sentinel, where the mine is yet to reach full production. The bottleneck there is the smelting capacity at Kansanshi, which the company is working around; First Quantum can either invest in a new smelter or use third-party smelters. In addition, we believe that First Quantum will need to take a decision on Kansanshi capex soon (the Kansanshi 2.5 plan was put on hold in 2015).

Zambia risks set to abate over the medium term; deleveraging to drive re-rating

In March 2018, the Zambian Revenue Authority imposed a c.US\$8 bn fine on First Quantum for "underpayment of taxes". With its 1Q2018 results, First Quantum stated that it had been through 1/3rd of the documents by value and that it expected the final amount to be small. This was reiterated with the 2Q results. We believe a resolution of this issue, ending the associated uncertainty, would be positively received by the market. We also expect significant deleveraging for First Quantum, which should allow the shares to continue to re-rate; we forecast net debt to EBITDA to decrease from 5x in 2017 to c.1x by 2020E. This reflects production ramps-up at Cobre Panama and capex winding down.

Valuation and key risks

We value First Quantum Minerals on a 50/50 blend of 5.5x 2018/19E EV/EBITDA, giving a 12m price target of C\$18 (previously C\$24). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Key risks to our view are projects underperforming, Cobre Panama being delayed, weaker copper prices and balance sheet stress.

Lundin Mining (LUMIN.ST/LUN.TO): Candelaria ramp-up proceeding according to plan; focus likely to remain on inorganic growth

We are Neutral rated on Lundin Mining (LUMIN.ST/LUN.TO) with 12-month price targets of Skr50/C\$7.3.

Strong B/S likely to be deployed towards M&A rather than enhanced returns

While Lundin has one of the strongest balance sheets in our coverage, we believe this is unlikely to translate into higher investor returns. In our view, the company's focus remains inorganic growth, and we would expect it to look for alternative acquisitions. While the company has a successful record of making acquisitions, we note that asset valuations, especially copper, are high at present. This creates the risk of dilution in the event of M&A.

While we expect operational improvement at Candelaria, we believe the investor focus is likely to be on corporate level activity. As a result, we take a more conservative view and remain Neutral rated on the stock.

Lack of immediate catalysts post withdrawal from Nevsun acquisition

Lundin Mining bid for Nevsun Resources on May 7. However, in September, Nevsun announced that it has entered into a friendly all-cash offer to be acquired by Zijin Mining for US\$1.41 bn. This is an all-cash deal and represents a 26% premium to Lundin Mining's offer. Lundin subsequently announced that it would not increase its offer for the company.

We had regarded the announced Nevsun acquisition as an important catalyst for the company. Nevsun intends to build the Timok project, which Lundin had expressed an interest in acquiring for the last couple of years, and which would have provided a growth opportunity for Lundin. However, following the termination of Lundin's approach for Nevsun, we see no immediate alternative catalysts.

Valuation and key risks

We value Lundin Mining (LUN.TO/LUMIN.ST) on a 50/50 blend of 5x (unchanged) 2018/19E EV/EBITDA, giving 12m price targets of C\$7.3/Skr50 (previously C\$7.5/Skr51). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX.

Key risks to our view are higher/lower copper and zinc prices, market assessment of potential M&A and operational performance.

KAZ Minerals: Growth ahead but balance sheet stretched; remain Neutral

We remain Neutral rated on KAZ Minerals with a 12-month price target of GBp575.

Growth delivered, more ahead...

KAZ Minerals has been the best performing stock in our coverage over the past three years as it has delivered on growth, bringing Bozshakol and Aktogay to production on time and reaching c.300Ktpa of copper production. While this has been a strong performance, investors we have spoken to had hoped that after the company approved the US\$1.2 bn Aktogay expansion and moved to sell a stake in its Koksay mine to China Nonferrous Metal Industry's Foreign Engineering and Construction Company Ltd, it was likely to move to a stage where it would delever and start to ramp up investor returns. However, the company more recently announced that it was acquiring the Baimskaya mine for US\$900 mn. This positions the company well for growth: Aktogay Phase II should start to deliver tonnes in 2022 and Baimskaya in 2025/26.

...but balance sheet concerns material after Baimskaya acquisition

We believe the key reason why the stock has underperformed this year is concern that the balance sheet could become stretched as the company starts to spend capex on Baimskaya in the next couple of years, together with the last remaining capex on the Aktogay expansion. In addition, the market appeared to have expectations of a period of delevering that would have led to a ramp-up in returns – a catalyst that has been pushed out by at least 7-8 years (on our price forecasts).

We believe that a key development to monitor over the next couple of years will be how the company decides to fund the Baimskaya project. We see three potential options: (1) going alone and using the balance sheet to fund the project; (2) project financing, using local banks/funding sources to fund the project; this normally locks the cash flows from the project for a period of time; or (3) bringing on a partner (as Anglo did with Quellavaco); we believe this is the most likely scenario as not only does it monetise the project but it also reduces the company's risk exposure.

Valuation and Key risks

We value KAZ Minerals on 5x 50/50 2018/19E EV/EBITDA to derive our 12-month price target of 575p (previously 4x 50/50 2018/19E EV/EBITDA to get to 450p). The reason for the increase in our multiple is the new work we have done on Baimskaya, which raises our confidence in the economic viability of the project. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Key risks to our view include higher/lower copper prices, higher/lower production volumes vs. our assumptions and FX. Another potential risk is the material capex coming ahead at Aktogay, and potentially at Baimskaya, which could present risk to the balance sheet.

Freeport (FCX): Highest copper exposure among the US mining stocks, Maintain Buy

We remain Buy rated on Freeport with a new 12-month price target of \$18.

Large, diversified copper miner set to emerge

FCX provides the most concentrated copper exposure across our North American coverage group, with copper expected to contribute 75% of full year revenues by our estimates and gold and molybdenum making up the remainder. FCX is currently developing the Lone Star project in Arizona, which leverages existing mine infrastructure from the Safford operation and is expected to produce 200 mn lbs/year for 20 years, starting toward the end of 2020. FCX also sees future potential for a large sulfide resource at El Abra and numerous other brownfield developments in the US and maintains a 39.6% ownership stake (54% after completion of the feasibility study) in the Lower Zone of the Timok copper-gold project in Serbia with Nevsun.

Final execution of the Grasberg divestment agreement and progress on the mine's transition underground will be the key drivers over 2019

The longstanding negotiations among FCX, Rio Tinto, and the Indonesian government regarding long-term operations and ownership of the Grasberg mine took another step toward full resolution with the September 27, 2018 signing of the Divestment Agreement. The agreement, which will see FCX cede majority ownership of the mine to Inalum, a state-owned company, while maintaining control of operations, investment, and governance, also allows Freeport to maintain essentially the same cash flows as expected pre-divestment. Remaining hurdles through year-end 2018 include anti-trust approvals, finalizing of the mining permit, and documentation and resolution of environmental issues, with the transaction expected to close during 1Q19. Once complete, we look for FCX to focus on the operating challenges at Grasberg, which faces a highly complex transition from an open-pit mine to a fully underground operation – adding some downside risks to production in the near term, in our view.

Valuation and key risks

Our 12-month price target moves to \$18 from \$19 on lower EBITDA projections over the next two years, somewhat offset by a higher valuation multiple and a higher NAV. Our price target is derived from an average of two valuation methods: (1) a 6.0x EV multiple on an average of our estimated EBITDA over two four quarter periods: forward quarters 5-8 (3Q19-2Q20) and forward quarters 9-12 (3Q20-2Q21), and (2) an NAV model with an overall discount rate of 8.7%.

Key Risks: (1) FCX and the Indonesian government could still fail to come to a resolution on environmental matters, leading to production cuts or shutdowns at the Grasberg mine; and (2) continued operational issues at the DMLZ or elsewhere could reduce Freeport's ability to meet production guidance and/or push increases in expected cash cost.

Teck Resources (TECK): Met Coal remains the key driver of earnings, cash flow - maintain Neutral

We remain Neutral rated on TECK/TECK_B.TO and increase our 12-month price targets to US\$30/C\$38 from US\$28/C\$37 on new copper and other commodity price assumptions.

TECK operates across base metals, bulks, and energy production

TECK maintains varied mining operations across the Americas, out of which we expect its copper assets to provide 22% of revenues/EBITDA in 2018. Exports of high-quality met coal out of the Pacific Northwest are TECK's most important operations today, contributing nearly 56% of EBITDA (ex corporate expense) in 2018E, while zinc and energy, on our estimates, contribute 20% and 2%, respectively. The company's copper assets today comprise Highland Valley (Canada, 100%), Andacollo (Chile, 90%), Quebrada Blanca (QB1, Chile, 76.5%), and its interest in Antamina (Peru, 22.5%). In total, on a consolidated basis for the three majority-owned mines plus attributable production from Antamina, we expect TECK to report 288kt of copper production for 2018.

Quadra Blanca "QB2" could double copper production by 2024

Since 2015, TECK's main project has been Fort Hills, a large-scale (C\$23 billion), long-lived Canadian scale oil sands operation with Suncor as majority owner and operator. Now, the company's attention is rotating toward copper, where TECK has 90% ownership of the C\$4.7 billion Quebrada Blanca 2 (QB2) copper project that could produce up to 300ktpa of copper at a "2nd quartile" cost position and a 25 year mine life – leveraging, as TECK's management has highlighted, only 25% of the current reserve and resource base. With regulatory approval of the EIA complete as of August 8, 2018, the company plans to sell down 20%-25% of its ownership to a development partner, chosen over 4Q18, and pursue Board approval soon afterward. First production is projected for mid-2021.

Valuation and key risks

Over the near term, our new reduced GIR copper forecast and changes in FX offset the benefits of marginally higher coking coal prices and lead to reductions in our earnings estimates for TECK. However, higher projected medium-term copper prices lift our NAV. While our forward quarter 5-8 EBITDA estimate decline, a slightly higher multiple and a higher NAV drive our 12-month price targets up to \$30/C\$38 from \$28/\$C37.

Key risks: (1) Commodity prices; (2) cost inflation; and (3) better-than-expected results of trials for alternative water treatment at Elkview, which could lower future expectations of coal operating costs and required sustaining capital.

Aurubis (NAFG.DE): Remain Neutral on continued bearish outlook for TC/RCs

We remain Neutral rated on Aurubis with a 12-month price target of €60.

Continue to see downside risks to TC/RCs in 2019

We continue to believe that treatment and refining charges are likely to face downward pressure in 2019, mainly as a result of the concentrate deficit we forecast the market to be in. Our forecasts imply a c.10% drop in both TCs and RCs, which implies the company's earnings profile remaining challenged despite the €60 mn cost-cutting programme.

Things that could surprise us

Factors that could surprise us to the upside here are: (1) refining charges: refining charges have remained strong mainly as a result of China imposing bans on certain type of copper imports. While our view remains that this was likely a one-off, China is looking to impose a ban on additional scrap imports; (2) the company has stated that it is looking to sell RFP (flat rolled products), its downstream business (the contribution to earnings from the business is c.€10 mn this year, on our estimates). If a sale of this business resulted in material cash inflows that were returned to shareholders, this would also be a positive catalyst; (3) M&A: The CEO has talked about acquiring more smelting business and growing earnings inorganically. If the company were to make a synergistic acquisition, this would be a positive catalyst for the stock.

Valuation and key risks

Our revised 12m price target of €60 (from €61) values the stock on a 5.5x EV/EBITDA multiple on 50/50 FY18/19E earnings. In our valuation, we assume: (1) benchmark TC/RCs settling at US\$75/t and US\$7.5/lb vs. this year's level of US\$82.5/t and US\$8.25/lb; and (2) scrap RCs coming off recent highs (-10% in FY19E vs. FY18E), albeit remaining elevated vs. history given the changes in China's import policy. Our estimates change on account of updated copper prices, and mtm of 3Q commodity prices and FX.

Key risks to our view include: lower/higher-than-expected tailwinds from a recovery in copper scrap availability post recent ferrous price moves; higher/lower sulfuric acid prices; and the efficiency program delivering above/below expectations.

KGHM (KGH.WA): Persistently weak FCF generation not priced in; Sell

We remain Sell rated on KGHM with a 12-month price target of PLN89.

KGH copper business

Copper contributes c.70% of KGHM's 2017E top line (the rest is mainly silver). Major copper assets for KGH are located in the south-western part of Poland. KGH also has production facilities in North America (Canada, United States) and a JV with Sumitomo Sierra Gorda (open-pit mine in Chile).

Investment thesis

Our Sell view is based on low cash generation stemming from production reconfiguration amid continued high capex (2018-20E average capex/sales of 15%). This leads to negative FCF for the company even amid a supportive macro environment (for example, in 1H18 when Cu prices were at three-year highs, KGH reported an FCF loss amounting to 9% of its sales (vs. broadly breakeven FCF in the previous five years)). Yet, even after a significant de-rating (down 22% YTD in US\$ terms), we believe the current valuation fails to reflect these challenges, with KGH trading at a premium to its own history (2019E EV/EBITDA of 5.5x vs. the five-year historical average of 3.2x). This is unjustified, in our view, given the continued suppressed FCF that we expect over the next three years. At spot macro assumptions (FX, metals), KGH trades at 6.9x EV/EBITDA and a 2% FCF yield for 2019E.

Valuation and key risks

We are Sell rated on KGHM. Our 12-month SOTP-based price target is PLN89 (up slightly from PLN88 on weaker FX). The increase in our estimates reflects our incorporation of our latest copper price assumptions. Our price target rises less significantly owing to an increase in net debt. Key risks to our view are higher-than-expected Cu/Ag prices, a weaker-than-expected PLN/USD, better-than-expected cost management, the disposal/closure of non-performing international assets and easing taxation in Poland.

MMG (1208.HK): Benefit from rising copper price, maintain Buy

We remain Buy rated on MMG with a 12-month price target of HK\$5.8

Lower guidance for Las Bambas copper production for 2018E

MMG has lowered its Las Bambas copper output guidance to 375kt-395kt from the previous 410kt-430kt for 2018 as: (1) instability events have affected mining rates and access to high-grade ore in Las Bambas; and (2) mill throughput rates have increased but have yet to reach the plan. MMG expects these issues to affect production in 2018 but not in the medium term. Hence, we revise down Las Bambas production by 7% to 382kt in 2018E and 3% to 400kt in 2019E to reflect our own view that geological issues for the mine are likely to continue for a while. We also revise up C1 cost to US\$1.1/lb from US\$1.0/lb for 2018E owing to lower production volume.

Benefit from rising copper prices

We believe MMG remains a key beneficiary under rising copper prices owing to its high leverage and high exposure to copper (80% of EBITDA in 2019E from copper). Despite lower copper price assumptions for 2018-20 and reduced production volumes from Las Bambas, we expect MMG to generate US\$0.99-1.21 bn of free cash flow with a free cash flow yield at 24%-29% for 2018-20E. With strong cash flow and a disciplined investment strategy, we expect net gearing to fall to 193% by 2020E from 682% in 2017A.

Valuation and key risks

Our 12-month target price of HK\$5.8 (from HK\$6.30) is based on historical P/B vs. ROE correlation, or 2019E P/B of 3.0x and ROE of 28%. We cut our earnings estimates by 30% for 2018, 33% for 2019 and 25% for 2020 to reflect lower copper price assumptions and output from Las Bambas in 2018-19. For each US\$0.5/lb change in the copper price, we estimate earnings would move by 58% for 2019.

Key risks to our price target and thesis are: (1) commodity prices including copper, zinc and lead; and (2) operational risks including a sudden decline in ore grade.

Zijin (2899.HK): Emerging copper play; maintain Buy

We remain Buy rated on Zijin-H/A with 12-month price targets of HK\$3.8 for H-share and Rmb4.8 for A-share.

Continued volume growth, benefit from rising copper/gold prices

We expect Zijin copper output to grow by 17%-25% in 2018-19, driven by ramp-up of the Kolwezi project and expansion of the Duobaoshan project, and copper output to almost double by 2022E from 2017A when the Kamoa project fully ramps up. By 2022, we estimate copper will contribute 57% of total gross profit (from 31% in 2017A) and gold will contribute 27%. Apart from growth from new project ramp-up and existing project expansion, Zijin is also looking for other acquisition opportunities. The company recently announced that it would acquire a 63% interest in RTB Bor Group in Serbia through public bidding and an increase of capital. The company has also proposed a cash takeover of Nevsun at a consideration of CAD\$6/share. Both transactions are still in the bidding process and we calculate Zijin would pay Rmb18 bn in total for acquisitions if it secures the two deals on the current proposed terms. We estimate that if completed, these two deals could bring at least 268kt of copper output to Zijin, versus Zijin's 2017 copper output of 208kt. However, as most projects in the deals are greenfield or need upgrades, the timing of operation and earnings contribution is uncertain.

Gold price assumptions change

Our commodities team recently revised down their gold price forecast to US\$1,262/oz in 2018 and US\$1,288/oz in 2019 from a prior US\$1,340/oz in 2018 and US\$1,450/oz in 2019 as they believe EM concerns have created a sizeable fall in financial and physical holdings. However, they still expect gradually higher gold prices driven by renewed EM demand.

Valuation and key risks

Our 12-month target prices of HK\$3.8 (from HK\$3.9) for H-share and Rmb4.8 (from Rmb4.9) for A-share are based on historical P/B vs. ROE correlation, or 2019E P/B of 1.9x/2.8x for H/A-share and ROE of 12%. We cut our earnings estimates by 9% for 2018, 20% for 2019 and 17% for 2020 to reflect lower copper and gold price assumptions.

Key risks to our price target and thesis are: (1) gold and copper prices: FY19E earnings change 11% for every US\$100/oz change in the gold price or 5% for every US\$0.01/lb change in the copper price; and (2) project execution, which is key to sustaining the company's growth profile.

Jiangxi Copper (0358.HK): Fairly valued with no volume growth

We remain Neutral rated on Jiangxi Copper H/A with a 12-month price target of HK\$11.5 for H-share and Rmb17.1 for A-share.

Fairly valued with no volume growth

In line with our commodities team's copper price forecast, we expect the SHFE copper price to average US\$2.96/lb in 2018 and US\$3.06/lb in 2019. Under this copper price assumption, we expect Jiangxi Copper's recurring profit to reach Rmb2.6 bn in 2018 and Rmb2.7 bn in 2019. We believe current valuation, at a 2019E EV/EBITDA of 5x, looks fair considering no volume growth for the company.

China copper demand to maintain low-single-digit growth

We expect Chinese copper demand growth to remain soft at 1%-3% per year for 2018-19. Our recent channel checks with fabricators suggested demand for copper was mostly flat MoM in September 2018, with a continued deceleration of order growth in air conditioners offset by a slight improvement in grid orders – remaining soft overall, in line with seasonal patterns. For each US\$0.5/lb change in the copper price, we estimate earnings would move by 23% for 2019E. The company's balance sheet remains healthy, with net gearing at 8%-14% for 2018-20E.

Valuation and key risks

Our 12-month target price is based on historical P/B vs. ROE correlation, or 2019E P/B of 0.7x/1.2x for H/A-share and ROE of 5.4%. Our price targets are HK\$11.5 (from HK\$12.7) for H-share and Rmb17.1 (from Rmb18.8) for A-share. We cut our earnings estimate by 12% for 2018, 19% for 2019 and 17% for 2020 to reflect lower copper price assumptions.

Key risks to our price target and thesis are: (1) Jiangxi Copper's earnings are highly leveraged to commodity prices (copper and gold), which depend on industry supply additions and global economic growth; (2) changes in government trade policy could have an impact on earnings; and (3) CNY fluctuations would have an impact on earnings.

Copper supply-demand balance

Exhibit 78: Copper Supply model

(*000 tonnes)	2010	2011	2012	2013	2014	2015	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Mine Production																
Base Conc Production	12813	12692	13150	14416	14765	15410	16344	16397	17172	17841	18573	19121	19442	18910	18796	18233
New Conc Production									0	10	171	266	481	750	966	1246
Adjustment									0	0	0	0	0	300	500	1000
Disruption Allowance									-500	-803	-937	-969	-996	-998	-1013	-1024
Total Concs/Precips Production	12813	12692	13150	14416	14765	15410	16344	16397	16672	17048	17806	18418	18926	18962	19249	19455
% change		-0.9%	3.6%	9.6%	2.4%	4.4%	6.1%	0.3%	1.7%	2.3%	4.5%	3.4%	2.8%	0.2%	1.5%	1.1%
Smelter Production																
less direct use concs	-18	-21	-18	-20	-21	-14	-11	-15	-20	-22	-20	-18	-16	-16	-16	-16
Concs available for smelting	12795	12671	13132	14396	14744	15396	16333	16382	16652	17026	17786	18400	18910	18946	19233	19439
Conc stock change	251	-203	170	668	-147	105	215	-117	-50	-100	250	150	150	0	-100	-300
Concs needed by smelters	12544	12874	12962	13728	14891	15291	16118	16499	16702	17126	17536	18250	18760	18946	19333	19739
Smelter losses	-478	-459	-495	-487	-556	-553	-509	-524	-551	-565	-579	-602	-619	-625	-638	-651
Add: Scrap/Resmelted blister	2646	2966	3130	2986	2811	2675	2893	3094	3090	3168	3244	3376	3471	3600	3673	3751
Total Smelter Production	14712	15381	15597	16227	17146	17413	18502	19069	19241	19729	20202	21024	21612	21920	22368	22839
Electro- and Fire-Refined Production																
less resmelted and direct use of blister	-689	-672	-781	-726	-796	-872	-985	-1083	-1068	-1049	-1009	-1084	-1134	-1134	-1134	-1134
Blister stock change	-68	-23	-66	-33	-2	42	136	158	-80	30	30	60	80	10	20	50
Blister required for refineries	14091	14732	14882	15534	16352	16499	17381	17828	18253	18650	19163	19880	20398	20776	21214	21655
Add Scrap	1622	1650	1764	1634	1693	1715	1537	1577	1597	1632	1677	1739	1785	1870	1909	1949
Electro-refined Cu Production	15713	16382	16646	17168	18045	18214	18918	19405	19850	20282	20840	21619	22183	22646	23123	23604
Electrowon Cathode Production																
Base SxEw Production	3236	3345	3510	3652	3712	3785	3825	3689	3692	3848	3826	3563	3398	3203	2999	2647
New SxEw Production									8	22	65	86	123	153	173	185
Adjustment									0	0	0	0	0	0	0	100
Disruption Allowance									-100	-174	-195	-182	-176	-168	-159	-147
Total SxEw Production	3236	3345	3510	3652	3712	3785	3825	3689	3600	3696	3697	3467	3344	3188	3013	2784
% change		3.4%	4.9%	4.0%	1.7%	1.9%	1.1%	-3.6%	-2.4%	2.7%	0.0%	-6.2%	-3.5%	-4.7%	-5.5%	-7.6%
Total Refined Cu Production	18950	19727	20156	20820	21757	21998	22743	23094	23449	23977	24537	25086	25527	25834	26136	26388
% change		4.1%	2.2%	3.3%	4.5%	1.1%	3.4%	1.5%	1.5%	2.3%	2.3%	2.2%	1.8%	1.2%	1.2%	1.0%

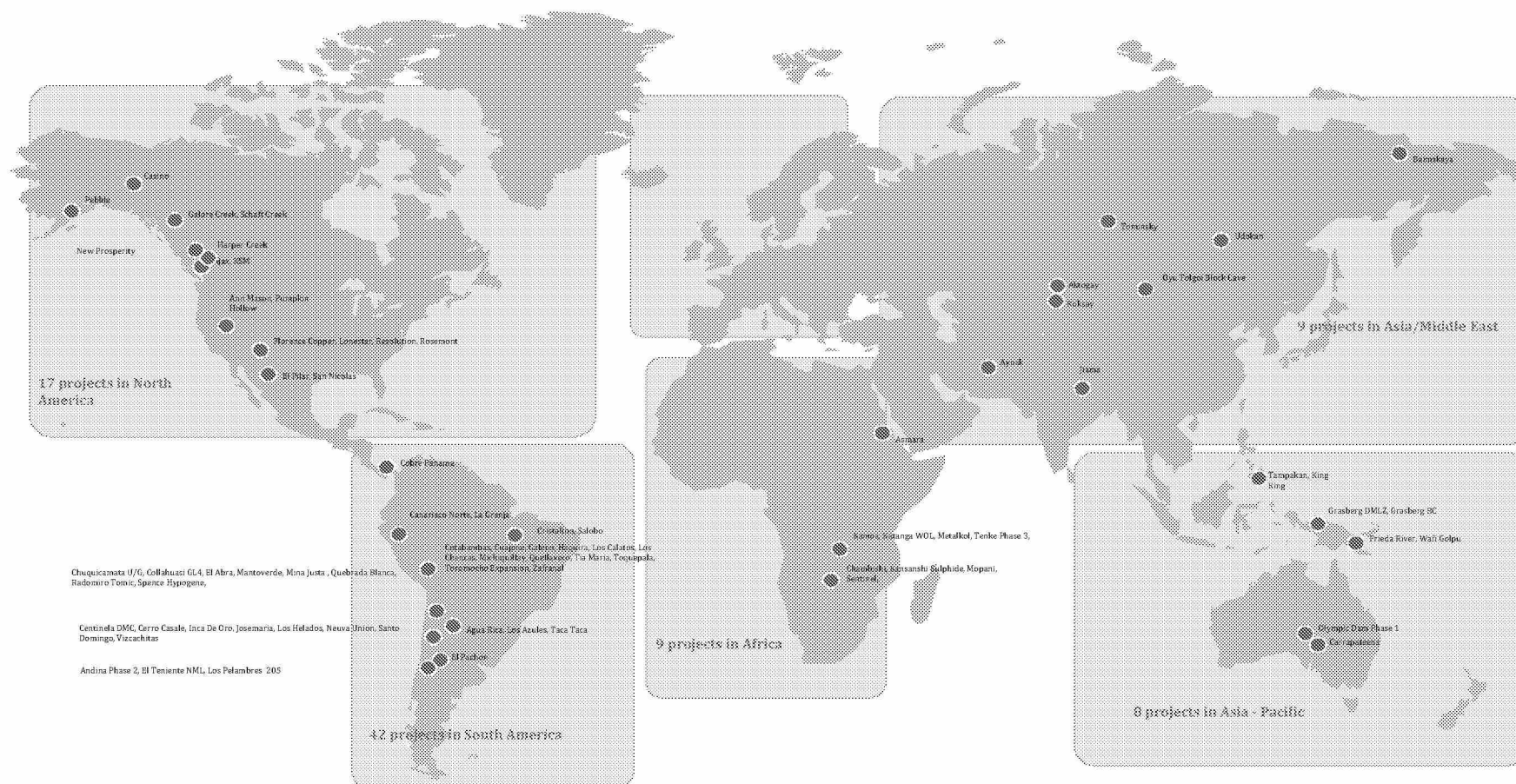
Source: Goldman Sachs Global Investment Research, Wood Mackenzie

Exhibit 79: Copper Demand model

('000 tonnes)	2011	2012	2013	2014	2015	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Consumption - DM															
US	1757	1762	1795	1815	1847	1853	1811	1721	1724	1708	1695	1689	1690	1696	1710
% change y/y	-0.5%	0.3%	1.9%	1.1%	1.8%	0.3%	-2.3%	-5.0%	0.2%	-0.9%	-0.8%	-0.4%	0.1%	0.4%	0.8%
Europe	4083	3735	3773	3835	3670	3701	3754	3822	3867	3918	3974	4030	4088	4147	4207
% change y/y	1.5%	-8.5%	1.0%	1.6%	-4.3%	0.8%	1.4%	1.8%	1.2%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%
Japan	1003	985	990	1050	1008	985	1025	1046	1078	1077	1074	1071	1067	1062	1058
% change y/y	-5.4%	-1.8%	0.5%	6.1%	-4.0%	-2.3%	4.1%	2.0%	3.1%	-0.1%	-0.3%	-0.3%	-0.4%	-0.5%	-0.4%
Other DM	1774	1626	1637	1600	1588	1625	1648	1608	1575	1547	1531	1523	1521	1526	1537
% change y/y	-10.2%	-8.3%	0.7%	-2.3%	-0.7%	2.3%	1.4%	-2.4%	-2.1%	-1.8%	-1.0%	-0.5%	-0.1%	0.3%	0.7%
Sub-Total DM	8617	8108	8195	8300	8113	8164	8238	8197	8244	8250	8274	8313	8366	8431	8512
% change y/y	-2.3%	-5.9%	1.1%	1.3%	-2.3%	0.6%	0.9%	-0.5%	0.6%	0.1%	0.3%	0.5%	0.6%	0.8%	1.0%
Consumption - EM															
China	7815	8204	9165	9836	10185	10678	11054	11526	11739	12033	12267	12472	12628	12773	12903
% change y/y	8.5%	5.0%	11.7%	7.3%	3.5%	4.8%	3.5%	4.3%	1.9%	2.5%	1.9%	1.7%	1.3%	1.1%	1.0%
Other EM	3175	3262	3326	3485	3628	3727	3748	3853	3995	4147	4363	4637	4974	5375	5846
% change y/y	-0.1%	2.7%	2.0%	4.8%	4.1%	2.7%	0.6%	2.8%	3.7%	3.8%	5.2%	6.3%	7.3%	8.1%	8.8%
Sub-Total EM	10990	11466	12491	13321	13813	14405	14802	15379	15734	16180	16630	17109	17602	18148	18749
% change y/y	5.9%	4.3%	8.9%	6.6%	3.7%	4.3%	2.8%	3.9%	2.3%	2.8%	2.8%	2.9%	2.9%	3.1%	3.3%
Total Global Consumption	19607	19574	20686	21621	21926	22569	23040	23576	23978	24430	24904	25422	25968	26579	27261
% change y/y	2.1%	-0.2%	5.7%	4.5%	1.4%	2.9%	2.1%	2.3%	1.7%	1.9%	1.9%	2.1%	2.1%	2.3%	2.6%
Total Global Production															
Mine Production	16037	16660	18068	18477	19194	20169	20086	20272	20743	21504	21885	22271	22150	22262	22240
% change y/y	-0.1%	3.9%	8.5%	2.3%	3.9%	5.1%	-0.4%	0.9%	2.3%	3.7%	1.8%	1.8%	-0.5%	0.5%	-0.1%
Refined Copper	19727	20156	20820	21757	21998	22743	23094	23449	23977	24537	25086	25527	25834	26136	26388
% change y/y	4.1%	2.2%	3.3%	4.5%	1.1%	3.4%	1.5%	1.5%	2.3%	2.3%	2.2%	1.8%	1.2%	1.2%	1.0%
Global Supply/Demand Balance	120	582	134	136	72	174	54	-126	-1	107	182	105	-134	-442	-873
Inventory															
Exchange (Comex, LME, SHFE)	545	589	507	307	482	539	543								
Other	2867	3405	3621	3957	3855	3972	4022								
Total	3412	3994	4128	4264	4337	4511	4565	4438	4437	4545	4727	4831	4697	4255	3382
Stock days of consumption	64	74	73	72	72	73	72	69	68	68	69	69	66	58	45
Cash Prices (annual average)															
Current Dollars (\$/t)	8810	7949	7322	6862	5494	4862	6166	6550	6885	7023	7163	7306	7729	8446	9764
Current Dollars (c/lb)	400	361	332	311	249	221	280	297	312	319	325	331	351	383	443
Real 2018 Dollars (\$/t)	9812	8674	7874	7261	5807	5075	6292	6550	6750	6750	6750	6750	7000	7500	8500
Real 2018 Dollars (c/lb)	445	393	357	329	263	230	285	297	306	306	306	306	318	340	386

Source: Goldman Sachs Global Investment Research, Wood Mackenzie

Exhibit 80: Map of projects analysed as part of the Copper Top Projects



Source: Company data

Exhibit 81: Copper Top Projects: Summary

Project	Owner	Year	Country	Stage	Project Type	Approved	Start Date	Anticipated Completion (US \$m)	Capex (US \$m)	Opex (US \$m)	NPV @ 8% Undiscounted	NPV @ 8% Discounted	IRR (%)	Payback (Years)	EBITDA (\$m/yr)	Production (\$m/yr)	Total Investment (\$m)	Total Revenue (\$m)	Total Profit (\$m)		
Agua Rica	Yamana Gold	2021	Argentina	Feasibility	Greenfield	No	2023	\$2,200	\$2,200	\$13,750	\$10,045	\$2,719	53.2	19.4%	19.4%	\$7,854	200 ktpa	160 ktpa	\$4,198	290 cty	48%
Alamosa Phase 2	Kaz Minerals	2021	Kazakhstan	Production	Brownfield	Yes	2021	\$1,200	\$1,200	\$12,285	\$10,285	\$2,000	31.6	14.9%	15.3%	\$4,479	510 ktpa	510 ktpa	\$4,479	388 cty	37%
Andina Phase 2	KOZ Minerals	2021	Kazakhstan	Production	Brownfield	Yes	2021	\$1,200	\$1,200	\$12,285	\$10,285	\$2,000	31.6	14.9%	15.3%	\$4,479	510 ktpa	510 ktpa	\$4,479	388 cty	37%
Antares	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Aurifer	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Aurifer	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$1,500	\$15,193	\$12,804	\$2,389	68.2	15.1%	15.1%	\$6,704	120 ktpa	110 ktpa	\$4,629	210 cty	42%
Bakana	Major Resources Corp.	2021	USA	Scoping	Greenfield	No	2024	\$1,500	\$												

Source: Company data, Wood Mackenzie, Goldman Sachs Global Investment Research

Exhibit 82: Top Projects: Copper production details to 2030E

Kt

	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
Agua Rica	0	0	0	0	0	0	0	76	152	200	200	200	200	200	200
Ajax	0	0	0	0	0	6	24	60	69	63	60	60	56	56	58
Aktogay Phase 2	0	0	0	0	0	33	76	81	81	81	81	60	60	60	60
Andina Phase 2	0	0	0	0	0	0	0	0	140	233	350	350	350	350	350
Ann Mason	0	0	0	0	0	0	0	60	101	121	121	121	121	121	121
Asmara	0	0	0	0	0	8	25	28	28	28	28	28	28	28	28
Aynak	0	0	0	0	0	0	0	0	39	79	158	319	319	319	319
Balmiskaya	0	0	0	0	0	0	0	0	0	0	34	99	180	219	286
Canariaco Norte	0	0	0	0	0	0	0	79	166	166	121	121	121	121	121
Carrapateña	0	0	0	0	66	66	66	64	64	64	64	64	64	64	64
Casino	0	0	0	0	0	0	0	5	10	42	80	84	76	77	77
Centinela DMC	0	0	0	0	0	0	0	14	72	130	130	130	130	130	130
Cerro Casale	0	0	0	0	0	0	0	0	23	76	110	110	110	110	110
Chambishi	0	0	11	37	59	59	59	59	59	59	59	59	59	59	59
Chuquicamata U/G	0	0	0	0	52	104	157	209	261	313	366	366	366	366	366
Cobre Panama	0	0	0	100	250	334	334	334	334	334	334	334	334	320	320
Collahuasi GL4	0	0	0	0	0	0	0	0	123	259	300	300	300	300	300
Cotabambas	0	0	0	0	0	0	0	18	36	72	72	72	72	72	72
Cristalino	0	0	0	0	0	0	0	0	55	121	121	121	121	121	121
Guajone	0	0	0	0	0	0	0	17	50	50	50	50	50	50	50
El Abra mill	0	0	0	0	0	0	0	0	0	0	36	72	145	217	217
El Arco	0	0	0	0	0	0	0	0	7	26	66	131	190	190	190
El Pachón	0	0	0	0	0	0	0	0	0	201	402	402	402	402	263
El Pilar	0	0	0	5	19	33	33	33	33	33	33	33	33	33	33
El Teniente NNM	0	0	0	0	0	0	0	32	190	317	434	434	434	434	434
Florence Copper	0	0	2	2	4	12	18	24	39	39	39	39	39	39	39
Frieda River	0	0	0	0	0	0	0	0	0	0	0	96	175	290	290
Galeno	0	0	0	0	0	0	0	0	0	82	115	164	164	164	164
Galore Creek	0	0	0	0	0	0	0	0	0	0	0	0	10	48	48
Grasberg DMLZ	12	9	8	13	66	167	245	187	187	187	187	161	161	161	161
Grasberg BC	8	11	12	23	89	189	305	384	429	310	310	310	310	310	310
Haquira	0	0	0	0	0	0	0	0	46	138	230	149	149	149	149
Harper Creek	0	0	0	0	0	0	0	0	20	61	71	71	59	59	59
Inca de Oro	0	0	0	0	0	0	0	0	0	30	59	59	59	59	44
Jlama Phase II	0	29	55	86	110	110	110	110	110	110	110	110	110	110	110
Josemaria	0	0	0	0	0	0	0	0	13	64	129	164	150	146	146
Kamoa-Kakula	0	0	0	0	0	0	0	24	48	233	377	369	360	406	406
Kansanshi Sulphide	0	0	0	0	0	16	65	65	65	65	65	65	65	65	65
Katanga	0	3	150	300	300	300	300	300	300	300	300	300	300	300	300
Kerr-Sulphurets-Mit	0	0	0	0	0	0	0	0	9	18	45	89	134	175	175
King King	0	0	0	0	0	0	0	0	37	94	94	75	75	71	71
Koksay	0	0	0	0	0	0	0	0	11	34	80	80	80	80	80
La Granja	0	0	0	0	0	0	0	0	0	0	0	27	73	82	82
Lone Star	0	0	0	0	3	15	37	89	89	89	89	89	89	89	89
Los Azules	0	0	0	0	0	0	0	0	206	220	169	174	230	229	229
Los Calatos	0	0	0	0	0	0	0	23	38	38	38	38	38	38	38
Los Chancas	0	0	0	0	0	0	0	10	29	48	78	126	126	126	126
Los Helados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Los Pelambres 20S	0	0	0	0	45	54	75	99	99	99	99	76	76	76	76
Mantoverde	0	0	0	0	0	0	10	49	79	79	79	79	79	79	79
Michiquillay	0	0	0	0	0	0	0	56	112	223	223	223	223	223	223
Metalkol	0	0	0	10	50	70	70	70	70	70	70	70	70	70	70
Mina Justa	0	0	0	0	0	22	59	79	110	110	110	110	110	110	110
Mirador	0	0	0	0	31	51	81	81	81	81	81	81	81	81	81
Mopani	0	0	31	67	99	99	99	99	99	99	99	99	99	99	99
Nueva Union	0	0	0	0	0	0	87	175	196	227	227	240	240	240	240
New Prosperity	0	0	0	0	0	0	0	0	52	53	53	53	53	53	53
Olympic Dam BFX	0	0	38	45	76	76	123	177	177	177	177	177	177	177	177
Oyu Tolgoi Block Cav	0	0	0	0	16	44	109	164	218	300	327	409	491	491	491
Pebble	0	0	0	0	0	0	0	0	0	0	17	87	140	175	175
Pulang	0	11	39	55	55	55	55	55	55	55	55	55	55	55	55
Pumpkin Hollow	0	0	0	0	7	9	18	45	90	125	125	125	125	125	125
Quebrada Blanca II	0	0	0	0	0	91	183	229	274	320	274	274	274	274	274
Quellaveco	0	0	0	0	0	0	0	23	69	115	184	313	313	313	313
Radomiro Tomic	0	0	0	0	0	0	0	0	99	148	197	296	346	394	394
Resolution	0	0	0	0	0	0	0	0	0	0	218	436	600	600	600
Rosemont	0	0	0	0	0	0	56	141	141	132	132	132	132	132	132
Salobo 3	0	0	0	0	0	4	16	47	51	51	51	51	56	61	65
San Nicolas	0	0	0	0	0	0	0	0	18	36	54	54	54	54	54
Santo Domingo	0	0	0	0	0	0	0	74	130	87	55	55	55	55	55
Schaft Creek	0	0	0	0	0	0	0	0	5	24	48	77	96	120	125
Sentinel	139	190	220	235	255	236	236	236	236	236	236	236	236	236	236
Spence growth opti	0	0	0	0	0	72	161	188	197	197	197	197	197	197	197
Taca Taca	0	0	0	0	0	0	0	0	61	153	244	237	237	237	237
Tampakan	0	0	0	0	0	0	0	0	104	261	417	451	375	375	375
Tia Maria	0	0	0	0	0	0	36	60	96	120	120	120	120	120	120
Tenke Phase 3	0	0	0	0	0	0	34	69	69	69	69	69	69	69	69
Tomlnsky	0	0	0	7	53	74	105	105	105	105	105	105	105	105	105
Toquepala	0	0	40	68	102	102	102	103	103	103	103	103	103	103	103
Toromocho expansi	0	0	0	0	18	35	70	110	123	110	110	110	110	110	110
Udokan	0	0	0	0	0	0	0	39	78	130	130	130	130	130	130
Vizcachitas	0	0	0	0	0	0	0	0	5	20	39	69	99	128	128
Wafi Golpu	0	0	0	0	0	0	0	0	48	97	101	154	207	207	207
Zafrañal	0	0	0	0	0	0	0	7	30	59	89	89	89	89	89

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 83: Top Projects: Copper risked projects summary

Project	Owner	Country	Status	Project type	Board approved	Start date	Announced Capex (US\$ mn)	GS Capex (US\$ mn)	Unit capex (US\$ / t) Cu	Unit capex (US\$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US\$ mn)	NPV @ 8% (2018+) (US\$ mn)	Payback (years)	IRR	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost (\$/t)	Total cash cost (c/lb)
<u>Aktogay Phase 2</u>	KAZ Minerals	Kazakhstan	Producing	Brownfield	Yes	2021	\$1,200	\$1,220	\$19,629 /t	\$18,558 /t	\$1,148	\$1,148	5.76	16.1%	16.1%	\$5,692 /t	81 ktpa	62 ktpa	\$3,649 /t	166 c/lb
<u>Asmara</u>	Sichuan R&BMIDC	Eritrea	Permitting	Greenfield	Yes	2021	\$559	\$609	\$26,386 /t	\$12,337 /t	\$668	\$668	6.92	23.1%	23.1%	\$6,932 /t	28 ktpa	23 ktpa	\$1,683 /t	76 c/lb
<u>Aynak</u>	China Metallurgical Group	Afghanistan	Permitting	Greenfield	No	2024	\$4,400	\$4,900	\$15,313 /t	\$15,313 /t	-\$543	-\$543	9.66	5.9%	5.9%	\$12,509 /t	320 ktpa	320 ktpa	\$5,374 /t	244 c/lb
<u>Baimskaya</u>	Baimskaya Mining Company	Russia	Feasibility	Greenfield	Yes	2024	\$5,500	\$5,600	\$31,206 /t	\$23,156 /t	\$2,350	\$2,381	6.35	12.4%	12.5%	\$5,433 /t	316 ktpa	179 ktpa	\$2,114 /t	96 c/lb
<u>Carrapateena</u>	OZ Minerals	Australia	Construction	Greenfield	Yes	2020	\$687	\$789	\$12,138 /t	\$10,126 /t	\$1,224	\$1,453	4.05	21.3%	31.4%	\$4,233 /t	66 ktpa	65 ktpa	\$3,628 /t	165 c/lb
<u>Casino</u>	Western Copper & Gold	Canada	Permitting	Greenfield	Yes	2023	\$3,345	\$3,545	\$41,357 /t	\$25,365 /t	-\$432	-\$399	11.78	6.7%	6.8%	\$8,069 /t	181 ktpa	86 ktpa	\$4,836 /t	219 c/lb
<u>Chambishi</u>	China Non-Ferrous Metals	Zambia	Construction	Greenfield	Yes	2018	\$700	\$750	\$13,777 /t	\$10,479 /t	\$228	\$408	8.17	13.4%	21.8%	\$6,800 /t	59 ktpa	54 ktpa	\$4,630 /t	210 c/lb
<u>Chuquibambilla U/G</u>	Codelco	Chile	Construction	Brownfield	Yes	2020	\$4,000	\$4,200	\$12,764 /t	\$11,222 /t	\$4,203	\$6,670	9.04	13.2%	24.6%	\$7,482 /t	366 ktpa	329 ktpa	\$4,266 /t	193 c/lb
<u>Cobre Panama</u>	First Quantum	Panama	Construction	Greenfield	Yes	2019	\$6,300	\$6,350	\$20,196 /t	\$19,164 /t	\$3,505	\$8,745	8.59	10.5%	38.7%	\$8,883 /t	334 ktpa	314 ktpa	\$4,021 /t	182 c/lb
<u>El Pilar</u>	Southern Copper	Mexico	Construction	Greenfield	Yes	2019	\$159	\$179	\$5,818 /t	\$5,818 /t	\$409	\$409	3.98	31.6%	31.6%	\$4,765 /t	33 ktpa	31 ktpa	\$4,300 /t	195 c/lb
<u>El Teniente NMM</u>	Codelco	Chile	Construction	Brownfield	Yes	2023	\$5,000	\$5,100	\$12,530 /t	\$11,904 /t	\$3,497	\$4,720	7.35	12.6%	17.2%	\$7,460 /t	434 ktpa	407 ktpa	\$4,567 /t	207 c/lb
<u>Florencia Copper</u>	Taseko Mines Ltd.	USA	Construction	Greenfield	Yes	2018	\$200	\$220	\$6,576 /t	\$6,576 /t	\$885	\$905	6.62	32.1%	38.1%	\$4,870 /t	39 ktpa	33 ktpa	\$3,971 /t	180 c/lb
<u>Grasberg BC</u>	Freeport	Indonesia	Construction	Brownfield	Yes	2016	\$6,400	\$6,700	\$27,245 /t	\$20,363 /t	\$5,817	\$9,643	6.91	13.0%	35.0%	\$7,514 /t	429 ktpa	246 ktpa	\$2,346 /t	106 c/lb
<u>Grasberg DMILZ</u>	Freeport	Indonesia	Construction	Brownfield	Yes	2015	\$3,100	\$3,200	\$25,562 /t	\$18,411 /t	\$2,998	\$5,346	9.68	13.3%	47.7%	\$7,180 /t	245 ktpa	125 ktpa	\$2,379 /t	108 c/lb
<u>Jiama Phase II</u>	China Gold International	China	Producing	Brownfield	Yes	2017	\$716	\$736	\$7,050 /t	\$5,495 /t	\$3,945	\$4,664	4.78	28.9%	--	\$4,380 /t	110 ktpa	104 ktpa	\$3,234 /t	147 c/lb
<u>Katanga</u>	Glencore	DRC	Construction	Brownfield	Yes	2017	\$1,096	\$1,159	\$4,237 /t	\$1,866 /t	\$17,184	\$17,567	2.05	198.0%	--	-\$1,243 /t	300 ktpa	274 ktpa	\$755 /t	34 c/lb
<u>Lone Star</u>	Freeport	USA	Construction	Greenfield	Yes	2020	\$850	\$900	\$10,992 /t	\$10,992 /t	\$632	\$683	7.87	12.8%	13.5%	\$4,870 /t	89 ktpa	82 ktpa	\$4,906 /t	223 c/lb
<u>Mantoverde</u>	Mantos Copper	Chile	Pre-feasibility	Brownfield	yes	2022	\$800	\$850	\$11,586 /t	\$10,863 /t	\$234	\$234	7.75	11.3%	11.3%	\$4,870 /t	79 ktpa	73 ktpa	\$4,880 /t	221 c/lb
<u>Metalkol</u>	ENRC	DRC	Construction	Greenfield	Yes	2019	\$833	\$900	\$13,514 /t	\$5,764 /t	\$4,884	\$5,608	3.89	30.1%	114.6%	\$3,820 /t	70 ktpa	67 ktpa	\$701 /t	32 c/lb
<u>Mirador</u>	Ecuacorriente S.A	Ecuador	Construction	Greenfield	Yes	2020	\$1,400	\$1,500	\$19,026 /t	\$17,139 /t	\$1,696	\$2,067	6.80	15.5%	20.1%	\$10,303 /t	81 ktpa	79 ktpa	\$3,415 /t	155 c/lb
<u>Mopani</u>	Glencore	Zambia	Construction	Brownfield	Yes	2018	\$950	\$1,025	\$10,807 /t	\$10,757 /t	\$2,126	\$3,161	5.04	19.3%	--	\$5,489 /t	99 ktpa	95 ktpa	\$3,764 /t	171 c/lb
<u>Olympic Dam BFX</u>	BHP Billiton	Australia	Permitting	Brownfield	No	2018	\$2,940	\$3,040	\$18,842 /t	\$17,499 /t	\$6,681	\$6,681	6.97	40%	39.6%	\$2,653 /t	177 ktpa	161 ktpa	\$2,612 /t	118 c/lb
<u>Oyu Tolgoi Block Cave</u>	Rio Tinto	Mongolia	Construction	Brownfield	Yes	2020	\$5,095	\$5,395	\$15,749 /t	\$13,374 /t	\$4,073	\$5,130	7.74	13.9%	17.0%	\$6,791 /t	491 ktpa	343 ktpa	\$3,891 /t	177 c/lb
<u>Pujiang</u>	Chinalco	China	Producing	Greenfield	Yes	2017	\$943	\$950	\$17,988 /t	\$16,061 /t	\$174	\$1,194	9.68	9.2%	--	\$8,221 /t	55 ktpa	53 ktpa	\$4,550 /t	206 c/lb
<u>Pumpkin Hollow</u>	Nevada Copper	USA	Construction	Greenfield	Yes	2020	\$1,050	\$1,100	\$12,197 /t	\$10,884 /t	\$1,330	\$1,596	7.28	17.2%	25.0%	\$4,938 /t	125 ktpa	90 ktpa	\$4,415 /t	200 c/lb
<u>Quellaveco</u>	Anglo American	Peru	Construction	Greenfield	Yes	2023	\$5,200	\$5,400	\$22,258 /t	\$20,184 /t	\$1,775	\$1,901	7.82	10.8%	11.0%	\$8,750 /t	313 ktpa	243 ktpa	\$4,527 /t	205 c/lb
<u>Santo Domingo</u>	Capstone Mining	Chile	Feasibility	Greenfield	Yes	2023	\$1,750	\$1,850	\$29,959 /t	\$17,588 /t	\$1,610	\$1,662	5.84	17.2%	17.8%	\$5,476 /t	130 ktpa	62 ktpa	\$1,251 /t	57 c/lb
<u>Sentinel</u>	First Quantum	Zambia	Producing	Greenfield	Yes	2015	\$2,000	\$2,000	\$9,086 /t	\$9,086 /t	\$5,275	\$6,929	5.39	19.7%	--	\$5,239 /t	255 ktpa	220 ktpa	\$4,126 /t	187 c/lb
<u>Spence growth option</u>	BHP Billiton	Chile	Construction	Brownfield	Yes	2021	\$2,460	\$2,510	\$14,492 /t	\$12,933 /t	\$3,851	\$3,851	5.32	18.8%	18.8%	\$5,697 /t	197 ktpa	173 ktpa	\$3,652 /t	166 c/lb
<u>Tia Maria</u>	Southern Copper	Peru	Permitting	Greenfield	Yes	2022	\$1,400	\$1,500	\$13,360 /t	\$13,360 /t	\$1,179	\$1,657	7.12	12.6%	18.8%	\$7,632 /t	120 ktpa	112 ktpa	\$4,041 /t	183 c/lb
<u>Tominsky</u>	Russian Copper Company	Russia	Construction	Greenfield	Yes	2018	\$1,183	\$1,283	\$16,042 /t	\$16,042 /t	\$2,058	\$2,375	nm	18.8%	27.9%	\$4,846 /t	105 ktpa	80 ktpa	\$3,479 /t	158 c/lb
<u>Toquepala</u>	Southern Copper	Peru	Construction	Brownfield	Yes	2018	\$1,300	\$1,310	\$13,091 /t	\$12,121 /t	\$2,343	\$3,318	6.00	16.2%	67.2%	\$6,325 /t	103 ktpa	100 ktpa	\$3,829 /t	174 c/lb
<u>Toromocho expansion</u>	Chinalco	Peru	Construction	Brownfield	Yes	2020	\$1,360	\$1,400	\$13,512 /t	\$11,601 /t	\$2,634	\$2,738	5.94	21.2%	23.5%	\$5,130 /t	123 ktpa	104 ktpa	\$3,494 /t	158 c/lb
Total - Risked	-	-	-	-	-	-	\$67,536	\$70,230	\$16,301 /t	\$13,071 /t	\$84,693	\$109,833	7.99	16.3%	32.7%	\$6,799 /t	5,455 ktpa	4,308 ktpa	\$510 /t	23 c/lb

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 84: Top Projects: Copper unapproved projects production details to 2030E

Project	Owner	Country	Status	Project type	Board approved	Start date	Announced Capex (US\$ mn)	GS Capex (US\$ mn)	Unit capex (US\$ / t)	Unit capex (US\$ / t)	NPV @ 8% (Ind. unit) (US\$ mn)	NPV @ 8% (2018+) (US\$ mn)	Payback (years)	IRR (2018+)	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost (\$/t)	Total cash cost (\$/t)	EBITDA margin
<u>Alax</u>	KGHM	Canada	Permitting	Greenfield	No	2021	\$900	\$1,000	\$18,868 /t	\$12,953 /t	\$336	\$370	8.36	14.0%	15.3%	\$6,249 /t	69 ktpa	53 ktpa	\$4,327 /t	196 c/lb	35%
<u>Agua Rica</u>	Yamana Gold	Argentina	Feasibility	Greenfield	No	2023	\$2,200	\$2,200	\$13,750 /t	\$10,043 /t	\$2,139	\$2,139	5.32	19.4%	19.4%	\$7,854 /t	200 ktpa	160 ktpa	\$4,198 /t	190 c/lb	44%
<u>Andina Phase 2</u>	Codelco	Chile	Feasibility	Brownfield	No	2024	\$6,800	\$7,600	\$22,157 /t	\$20,644 /t	\$319	\$319	9.44	8.6%	8.6%	\$8,796 /t	350 ktpa	343 ktpa	\$4,498 /t	204 c/lb	46%
<u>Ann Mason</u>	Mason Resources Corp	USA	Scoping	Greenfield	No	2023	\$1,351	\$1,451	\$13,191 /t	\$12,284 /t	\$821	\$821	6.74	15.1%	15.1%	\$5,702 /t	121 ktpa	110 ktpa	\$4,629 /t	210 c/lb	42%
<u>Aynak</u>	China Metallurgical Group Corp.	Afghanistan	Permitting	Greenfield	No	2024	\$4,400	\$4,900	\$15,313 /t	\$15,313 /t	-\$543	-\$543	9.66	5.9%	5.9%	\$12,509 /t	320 ktpa	320 ktpa	\$5,374 /t	244 c/lb	36%
<u>Canariaco Norte</u>	Candente Copper Corp	Peru	Feasibility	Greenfield	No	2023	\$1,565	\$1,700	\$14,286 /t	\$13,153 /t	\$1,939	\$1,939	4.32	21.1%	21.1%	\$5,259 /t	166 ktpa	119 ktpa	\$3,760 /t	171 c/lb	58%
<u>Centinela DMC</u>	Antofagasta	Chile	Feasibility	Brownfield	No	2022	\$2,700	\$2,970	\$24,829 /t	\$18,425 /t	\$726	\$726	9.11	10.1%	10.1%	\$9,122 /t	130 ktpa	120 ktpa	\$4,065 /t	184 c/lb	43%
<u>Cerro Casale</u>	Barrick Gold	Chile	Permitting	Greenfield	No	2025	\$6,000	\$6,000	\$57,313 /t	\$25,032 /t	\$989	\$989	8.66	10.1%	10.1%	\$9,964 /t	110 ktpa	105 ktpa	\$4,438 /t	201 c/lb	66%
<u>Collahuasi GL4</u>	Glencore	Chile	Pre-feasibility	Brownfield	No	2025	\$4,000	\$4,350	\$14,921 /t	\$14,041 /t	\$2,888	\$2,888	6.53	15.2%	15.2%	\$6,651 /t	300 ktpa	292 ktpa	\$4,742 /t	215 c/lb	45%
<u>Cotabambas</u>	Panoro Minerals Ltd.	Peru	Pre-feasibility	Greenfield	No	2023	\$1,533	\$1,633	\$24,123 /t	\$17,347 /t	\$218	\$218	9.41	9.7%	9.7%	\$8,210 /t	72 ktpa	68 ktpa	\$4,144 /t	188 c/lb	39%
<u>Cristalino</u>	Vale	Brazil	Pre-feasibility	Greenfield	No	2025	\$1,500	\$1,550	\$13,129 /t	\$12,183 /t	\$1,686	\$1,686	4.91	17.8%	17.8%	\$8,672 /t	121 ktpa	118 ktpa	\$4,285 /t	194 c/lb	51%
<u>Cuacione</u>	Southern Copper	Peru	Feasibility	Brownfield	No	2024	\$500	\$500	\$10,200 /t	\$9,809 /t	\$1,049	\$1,049	3.73	24.9%	24.9%	\$7,920 /t	50 ktpa	49 ktpa	\$4,919 /t	232 c/lb	53%
<u>El Abra mill</u>	Freeport	Chile	Pre-feasibility	Brownfield	No	2027	\$5,074	\$5,274	\$15,502 /t	\$15,502 /t	-\$2,230	-\$2,230	6.00	-8.9%	-8.9%	\$4,870 /t	347 ktpa	340 ktpa	\$7,515 /t	371 c/lb	0%
<u>El Arco</u>	Southern Copper	Mexico	Scoping	Greenfield	No	2026	\$3,000	\$3,200	\$18,955 /t	\$16,936 /t	\$890	\$890	8.05	11.1%	11.1%	\$4,870 /t	190 ktpa	169 ktpa	\$8,333 /t	348 c/lb	0%
<u>El Pachón</u>	Glencore	Argentina	Pre-feasibility	Greenfield	No	2026	\$4,100	\$4,500	\$16,243 /t	\$15,878 /t	\$1,699	\$1,699	6.70	13.0%	13.0%	\$10,029 /t	402 ktpa	277 ktpa	\$4,703 /t	213 c/lb	0%
<u>Frieda River</u>	Guangdong Rising H.K. (Holdings)	PNG	Permitting	Greenfield	No	2027	\$3,600	\$3,800	\$22,782 /t	\$17,861 /t	\$2,361	\$2,361	5.01	18.8%	18.8%	\$8,499 /t	290 ktpa	167 ktpa	\$3,070 /t	139 c/lb	0%
<u>Gaiore Creek</u>	Teck Resources	Canada	Pre-feasibility	Greenfield	No	2029	\$5,160	\$5,460	\$38,551 /t	\$29,614 /t	-\$169	-\$169	8.94	7.5%	7.5%	\$4,870 /t	158 ktpa	142 ktpa	\$4,299 /t	195 c/lb	0%
<u>Gaiore</u>	China Minmetals	Peru	Feasibility	Greenfield	No	2026	\$2,500	\$2,700	\$17,161 /t	\$14,288 /t	\$1,252	\$1,252	6.24	15.4%	15.4%	\$6,471 /t	164 ktpa	157 ktpa	\$3,876 /t	176 c/lb	0%
<u>Haquila</u>	First Quantum	Peru	Scoping	Greenfield	No	2025	\$2,058	\$2,500	\$16,882 /t	\$15,275 /t	\$1,211	\$1,211	6.92	13.9%	13.9%	\$6,906 /t	230 ktpa	148 ktpa	\$4,741 /t	215 c/lb	46%
<u>Harper Creek</u>	Yellowhead Mining Inc.	Canada	Permitting	Greenfield	No	2025	\$799	\$960	\$17,878 /t	\$16,767 /t	\$613	\$613	6.27	15.6%	15.6%	\$5,329 /t	71 ktpa	54 ktpa	\$4,786 /t	217 c/lb	48%
<u>Inca de Oro</u>	Guangdong Rising H.K. (Holdings)	Chile	Feasibility	Greenfield	No	2026	\$800	\$1,000	\$21,914 /t	\$17,903 /t	\$220	\$220	7.65	10.9%	10.9%	\$7,835 /t	59 ktpa	46 ktpa	\$4,260 /t	193 c/lb	0%
<u>Josemaria</u>	NGEx Resources	Argentina	Pre-feasibility	Greenfield	No	2025	\$2,000	\$2,000	\$15,385 /t	\$11,359 /t	\$318	\$318	5.43	11.3%	11.3%	\$10,971 /t	164 ktpa	130 ktpa	\$4,763 /t	216 c/lb	46%
<u>Kamoa-Kakula</u>	Ivanhoe Mines	DRC	Pre-feasibility	Greenfield	No	2024	\$2,400	\$2,500	\$5,152 /t	\$5,152 /t	\$10,370	\$10,370	6.27	28.8%	28.8%	\$5,650 /t	623 ktpa	485 ktpa	\$3,989 /t	181 c/lb	62%
<u>Kansanshi Sulphide</u>	First Quantum	Zambia	Permitting	Brownfield	No	2021	\$565	\$585	\$9,429 /t	\$8,836 /t	\$553	\$553	4.88	20.8%	20.8%	\$5,689 /t	65 ktpa	62 ktpa	\$4,294 /t	195 c/lb	49%
<u>Kerr-Sulphurets-Mitch</u>	Seabridge Gold	Canada	Pre-feasibility	Greenfield	No	2025	\$5,500	\$5,800	\$41,312 /t	\$18,852 /t	\$496	\$511	6.90	9.1%	9.1%	\$5,967 /t	175 ktpa	140 ktpa	\$2,497 /t	113 c/lb	57%
<u>Kina King</u>	St. Augustine Copper&Gold	Philippines	Permitting	Greenfield	No	2025	\$2,042	\$2,300	\$37,597 /t	\$22,900 /t	\$683	\$683	7.30	12.0%	12.0%	\$12,706 /t	94 ktpa	61 ktpa	\$3,728 /t	169 c/lb	51%
<u>Koksav</u>	KAZ Minerals	Kazakhstan	Pre-feasibility	Greenfield	No	2025	\$1,500	\$1,700	\$22,431 /t	\$20,411 /t	\$413	\$413	10.60	11.6%	11.6%	\$6,686 /t	80 ktpa	76 ktpa	\$5,193 /t	236 c/lb	44%
<u>La Grania</u>	Rio Tinto	Peru	Pre-feasibility	Greenfield	No	2028	\$7,500	\$7,500	\$18,195 /t	\$18,195 /t	\$1,612	\$1,612	10.10	11.9%	11.9%	\$7,431 /t	501 ktpa	412 ktpa	\$4,846 /t	220 c/lb	0%
<u>Los Azules</u>	McEwen Mining	Argentina	Pre-feasibility	Greenfield	No	2025	\$2,641	\$2,691	\$16,054 /t	\$14,795 /t	\$2,104	\$2,104	5.29	18.6%	18.6%	\$4,870 /t	230 ktpa	168 ktpa	\$4,278 /t	194 c/lb	46%
<u>Los Calatos</u>	CD Capital	Peru	Scoping	Greenfield	No	2023	\$655	\$705	\$18,598 /t	\$16,345 /t	\$462	\$462	7.16	14.8%	14.8%	\$6,848 /t	38 ktpa	38 ktpa	\$4,095 /t	186 c/lb	50%
<u>Los Chancas</u>	Southern Copper	Peru	Scoping	Greenfield	No	2024	\$2,800	\$2,900	\$25,679 /t	\$20,729 /t	\$543	\$543	10.31	10.0%	10.0%	\$4,870 /t	126 ktpa	113 ktpa	\$4,839 /t	219 c/lb	47%
<u>Los Helados</u>	NGEx Resources	Chile	Pre-feasibility	Greenfield	No	2031	\$1,225	\$1,325	\$8,520 /t	\$7,025 /t	\$1,727	\$1,727	4.38	16.3%	16.3%	\$5,817 /t	200 ktpa	156 ktpa	\$4,911 /t	223 c/lb	0%
<u>Los Pelambres 205</u>	Antofagasta	Chile	Feasibility	Brownfield	No	2020	\$1,800	\$1,950	\$25,023 /t	\$23,847 /t	\$27	\$118	10.28	8.3%	9.1%	\$8,246 /t	99 ktpa	78 ktpa	\$4,281 /t	194 c/lb	47%
<u>Michiquillay</u>	Southern Copper	Peru	Scoping	Greenfield	No	2023	\$2,500	\$2,700	\$12,893 /t	\$11,314 /t	\$569	\$631	6.28	16.0%	16.0%	\$6,863 /t	223 ktpa	209 ktpa	\$1,516 /t	69 c/lb	43%
<u>Mina Justa</u>	Minsur	Peru	Feasibility	Greenfield	No	2021	\$1,400	\$1,500	\$19,130 /t	\$19,130 /t	\$336	\$336	6.64	11.5%	11.5%	\$7,438 /t	110 ktpa	78 ktpa	\$3,923 /t	178 c/lb	60%
<u>Nueva Union</u>	Gold Corp.	Chile	Feasibility	Greenfield	No	2022	\$3,500	\$3,800	\$21,881 /t	\$16,593 /t	\$3,458	\$3,767	6.23	15.9%	17.7%	\$6,105 /t	240 ktpa	174 ktpa	\$3,599 /t	163 c/lb	51%
<u>New Prosperity</u>	Taseko Mines Limited	Canada	Pre-feasibility	Greenfield	No	2025	\$814	\$1,200	\$23,509 /t	\$13,274 /t	\$995	\$999	5.75	18.5%	18.6%	\$3,557 /t	53 ktpa	51 ktpa	\$3,244 /t	147 c/lb	45%
<u>Pebble</u>	Northern Dynasty	USA	Pre-feasibility	Greenfield	No	2027	\$4,690	\$5,800	\$19,265 /t	\$13,089 /t	\$4,306	\$4,306	9.74	13.1%	13.1%	\$4,604 /t	350 ktpa	301 ktpa	\$2,984 /t	135 c/lb	0%
<u>Quebrada Blanca II</u>	Teck Resources	Chile	Permitting	Brownfield	No	2022	\$4,714	\$4,900	\$18,543 /t	\$17,314 /t	\$3,387	\$3,540	7.34	13.9%	14.4%	\$7,083 /t	320 ktpa	264 ktpa	\$4,349 /t	197 c/lb	51%
<u>Radomiro Tomic</u>	Codelco	Chile	Feasibility	Brownfield	No	2024	\$5,400	\$5,900	\$17,201 /t	\$16,714 /t	\$3,654	\$3,654	8.14	15.4%	15.4%	\$6,553 /t	394 ktpa	343 ktpa	\$4,323 /t	196 c/lb	46%
<u>Resolution</u>	Rio Tinto	USA	Scoping	Greenfield	No	2027	\$6,000	\$6,500	\$13,040 /t	\$12,279 /t	\$4,197	\$4,309	5.35	14.6%	15.0%	\$5,500 /t	600 ktpa	498 ktpa	\$4,509 /t	205 c/lb	45%
<u>Rosemont</u>	Hudbay Minerals	USA	Permitting	Greenfield	No	2022	\$1,921	\$2,021	\$16,136 /t	\$14,058 /t	\$685	\$685	6.41	13.4%	13.4%	\$6,005 /t	141 ktpa	125 ktpa	\$4,080 /t	185 c/lb	49%
<u>Salobo 3</u>	Vale	Brazil	Pre-feasibility	Brownfield	No	2022	\$1,000	\$1,100	\$18,343 /t	\$12,727 /t	\$1,817	\$1,817	5.14	19.5%	19.5%	\$4,870 /t	65 ktpa	60 ktpa	\$2,079 /t	94 c/lb	63%
<u>San Nicolas</u>	Teck Resources	Mexico	Pre-feasibility	Greenfield	No	2025	\$650	\$750	\$14,621 /t	\$8,641 /t	\$1,140	\$1,140	3.79	24.4%	24.4%	\$4,870 /t	54 ktpa	51 ktpa	\$2,685 /t	122 c/lb	61%
<u>Schaff Creek</u>	Teck Resources	Canada	Feasibility	Greenfield	No	2024	\$3,257	\$3,700	\$34,071 /t	\$23,834 /t	\$7	\$8	10.43	8.0%	8.0%	\$7,428 /t	125 ktpa	109 ktpa	\$5,252 /t	238 c/lb	44%
<u>Taca Taca</u>	First Quantum	Argentina	Scoping	Greenfield	No	2025	\$3,431	\$3,900	\$17,192 /t	\$15,056 /t	\$2,456	\$2,456	6.84	15.8%	15.8%	\$9,437 /t	244 ktpa	227 ktpa	\$3,957 /t	179 c/lb	59%
<u>Tampakan</u>	Indophill Resources	Philippines	Feasibility	Greenfield	No	2025	\$5,900	\$6,100	\$16,920 /t	\$14,004 /t	\$3,406	\$3,406	5.81	16.2%	16.2%	\$9,007 /t	451 ktpa	361 ktpa	\$4,498 /t	204 c/lb	52%
<u>Tenke Phase 3</u>	China Molybdenum	DRC	Feasibility	Brownfield	No	2022	\$500	\$600	\$9,045 /t	\$5,214 /t	\$1,443	\$1,443	2.51	42.8%	42.8%	\$4,117 /t	69 ktpa	66 ktpa	\$2,829 /t	128 c/lb	61%
<u>Udokan</u>	Baikal Mining Company	Russia	Construction	Greenfield	No	2023	\$2,450	\$2,695	\$21,117 /t	\$20,029 /t	\$1,141	\$1,422	8.13	11.4%	12.8%	\$6,799 /t	130 ktpa	128 ktpa	\$4,153 /t	188 c/lb	54%
<u>Wafi Golpu</u>	Harmony Gold	PNG	Feasibility	Greenfield	No	2025	\$2,800	\$3,000	\$15,744 /t	\$12,732 /t	\$3,388	\$3,388	5.98	18.2%	18.2%	\$9,171 /t	207 ktpa	191 ktpa	\$1,894 /t	86 c/lb	56%
<u>Zafrañal</u>	Teck Resources	Peru	Pre-feasibility	Greenfield	No	2024	\$1,157	\$1,270	\$32,523 /t	\$29,983 /t	-\$93	-\$93	8.72	6.9%	6.9%	\$9,148 /t	89 ktpa	39 ktpa	\$4,962 /t	225 c/lb	38%
Total - Unapproved	-	-	-	-	-	-	\$149,092	\$160,680	\$18,155 /t	\$15,409 /t	\$79,282	\$80,283	6.04	13.8%	13.9%	\$7,307 /t	10,532 ktpa	8,851 ktpa	\$97 /t	4 c/lb	50%

Source: Company data, Goldman Sachs Global Investment Research

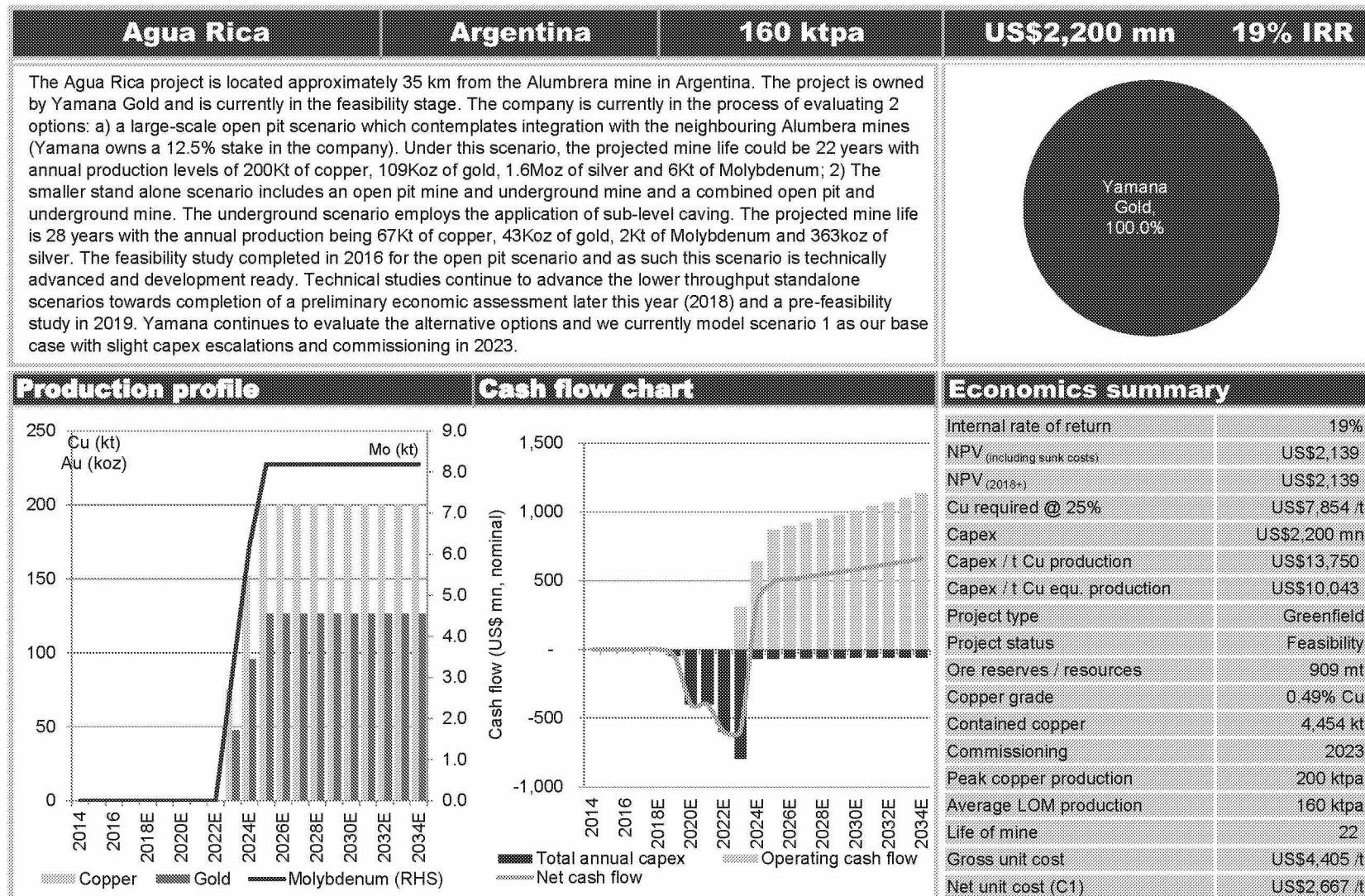
Modeling each project – how we do it?

Below is a summary of how we model each project:

- We model the production profile of each project using the most recent information available. Where applicable, we include specific company guidance on production profiles and otherwise model output according to average LOM production information. Unless otherwise indicated by company guidance, we use reserve/resource details to determine the total mine life of each project.
- Based on disclosed grades, we include all by-product production to compute the Cu equivalent price requirements.
- Revenues of each project are determined using our GS commodities pricing assumptions for 2017-2020E, and we add 3% of price inflation for each year thereafter.
- Computing costs, we assume cost deflation of 1% over the next four years and inflation of c.3% thereafter. Unless otherwise specified by companies, we use a 50% split between costs in local currency and USD. Where applicable, we apply our GS forecasts for currencies over 2017-2020E – alternatively rates are set at spot.
- We add estimates for project D&A as well as royalties & taxes depending on the overall life of mine and jurisdiction of each project.
- We follow company guidance on initial capex assumptions and escalate growth capex estimates based on our assumptions. In term of sustaining capex, we model this as a percentage of revenue across all projects (we adjust this percentage where company guidance is available and the overall level of sustaining capex is significantly different from our assumption).
- To discount the cash flows computed, we apply a discount rate of across all projects; note that NPV 2017+ numbers exclude any cash flows incurred before 2017.
- Finally, to compute the required copper price for each project we set a required IRR based on the jurisdiction of each project.

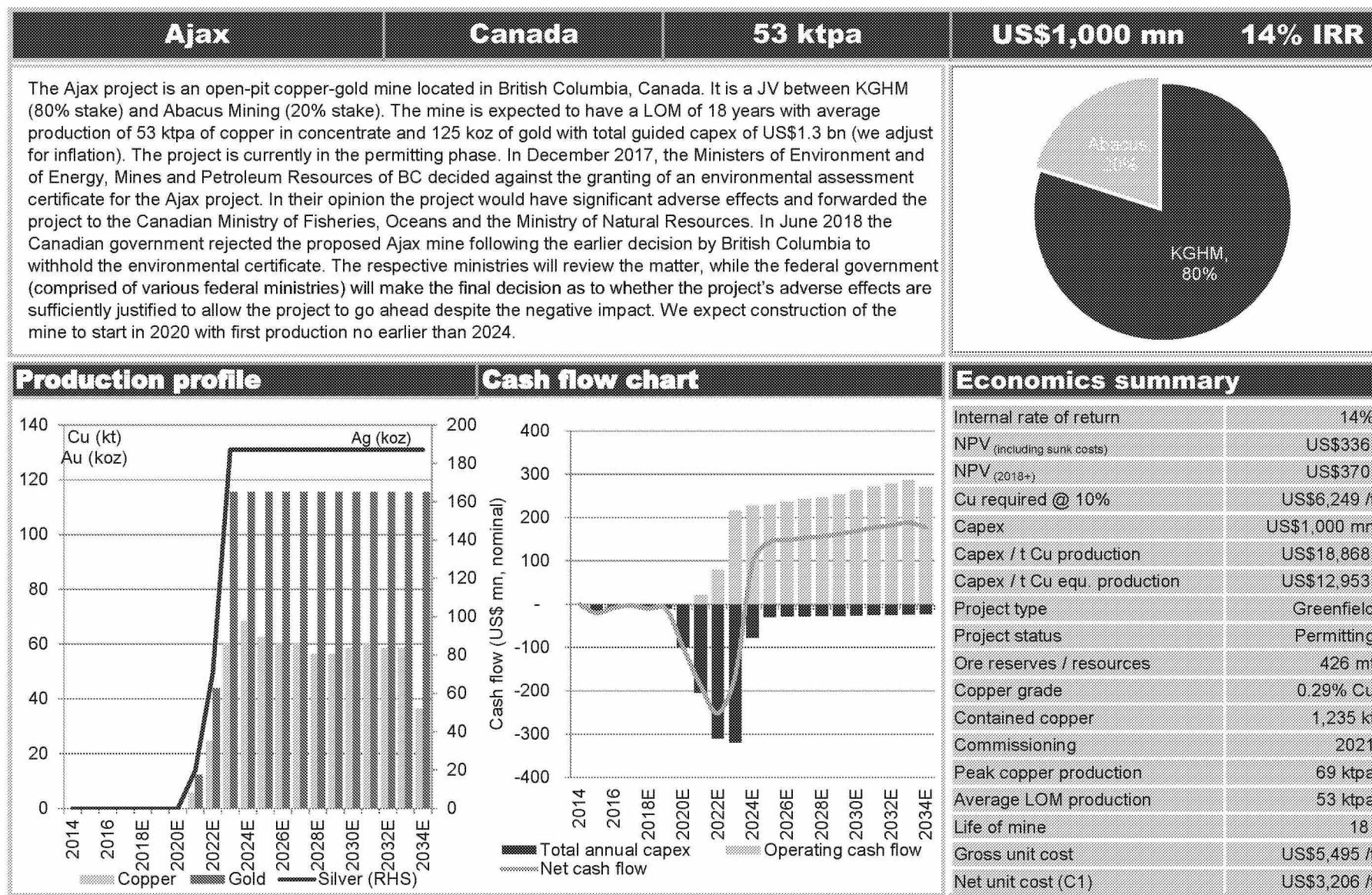
Top Projects: Copper summaries

Exhibit 85: Agua Rica



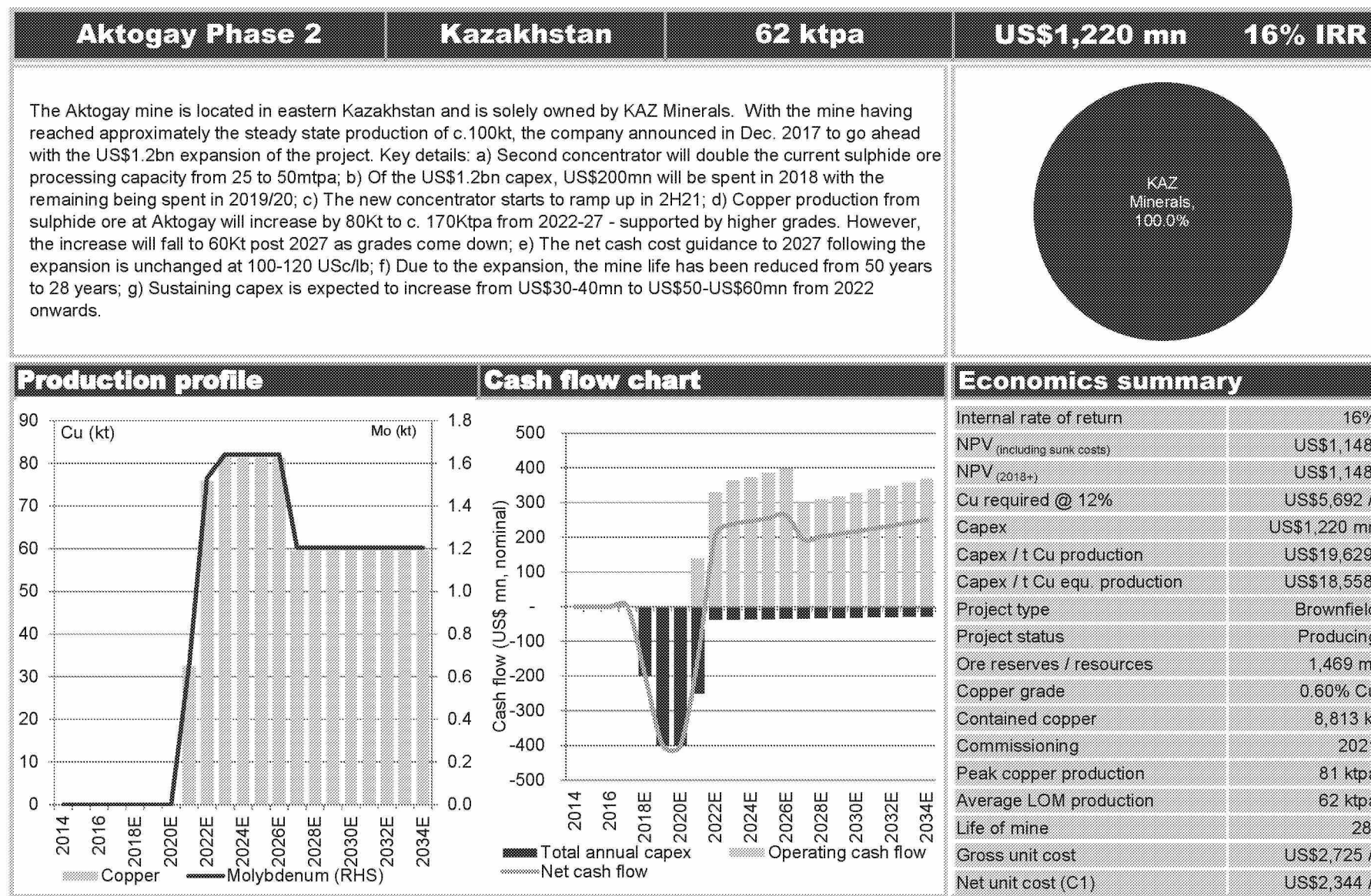
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 86: Ajax



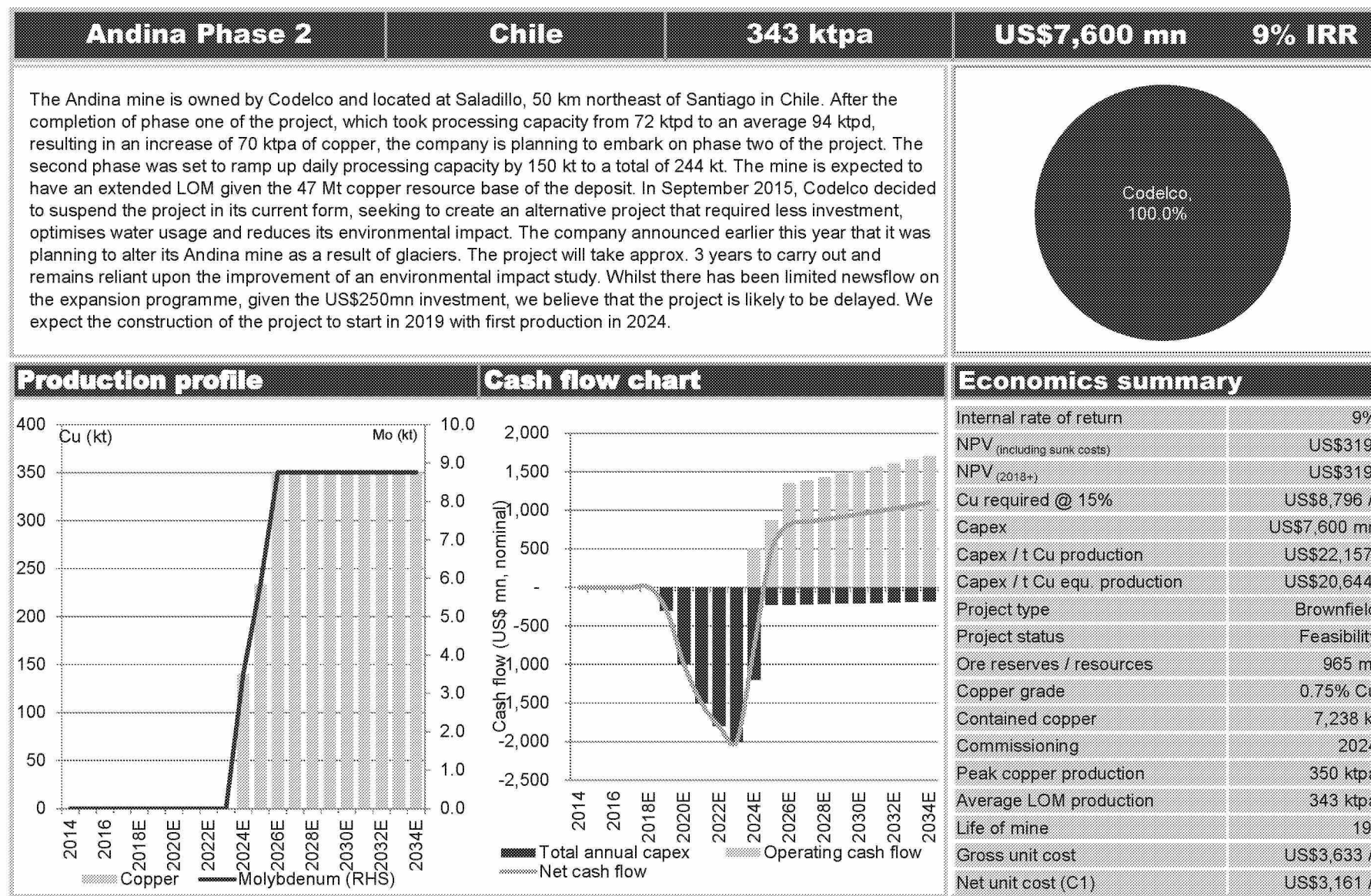
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 87: Aktogay Phase 2



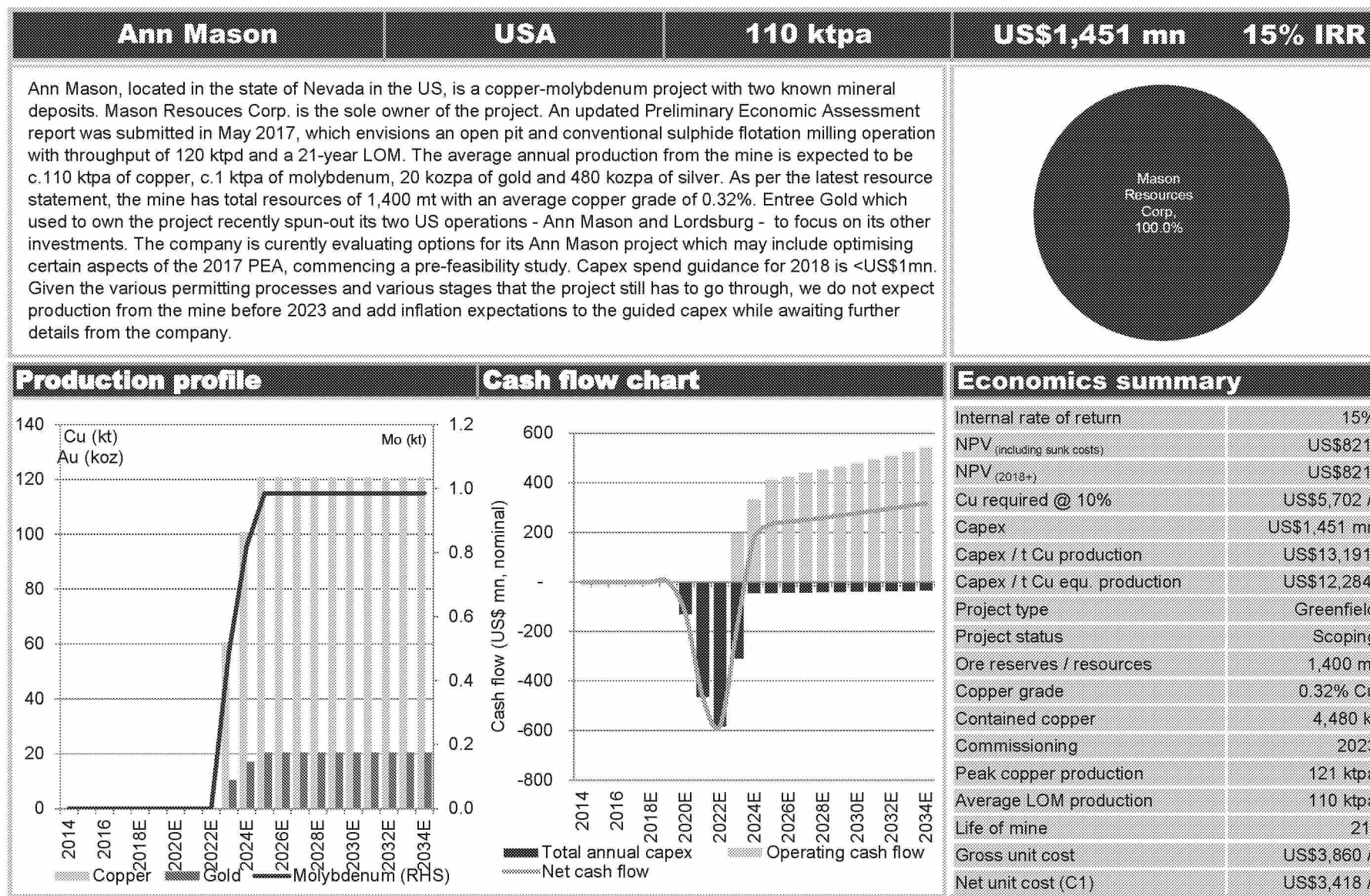
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 88: Andina Phase 2



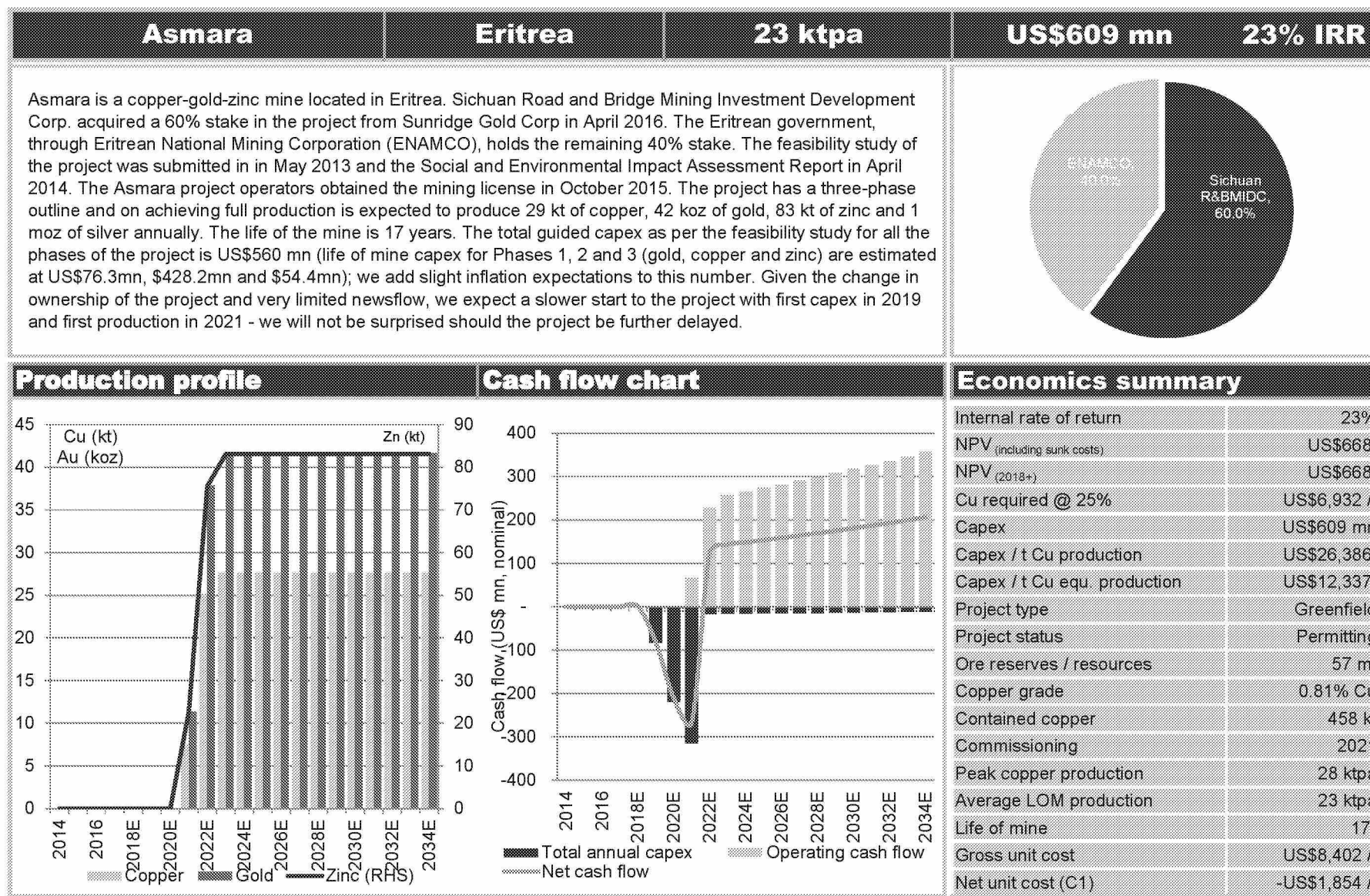
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 89: Ann Mason



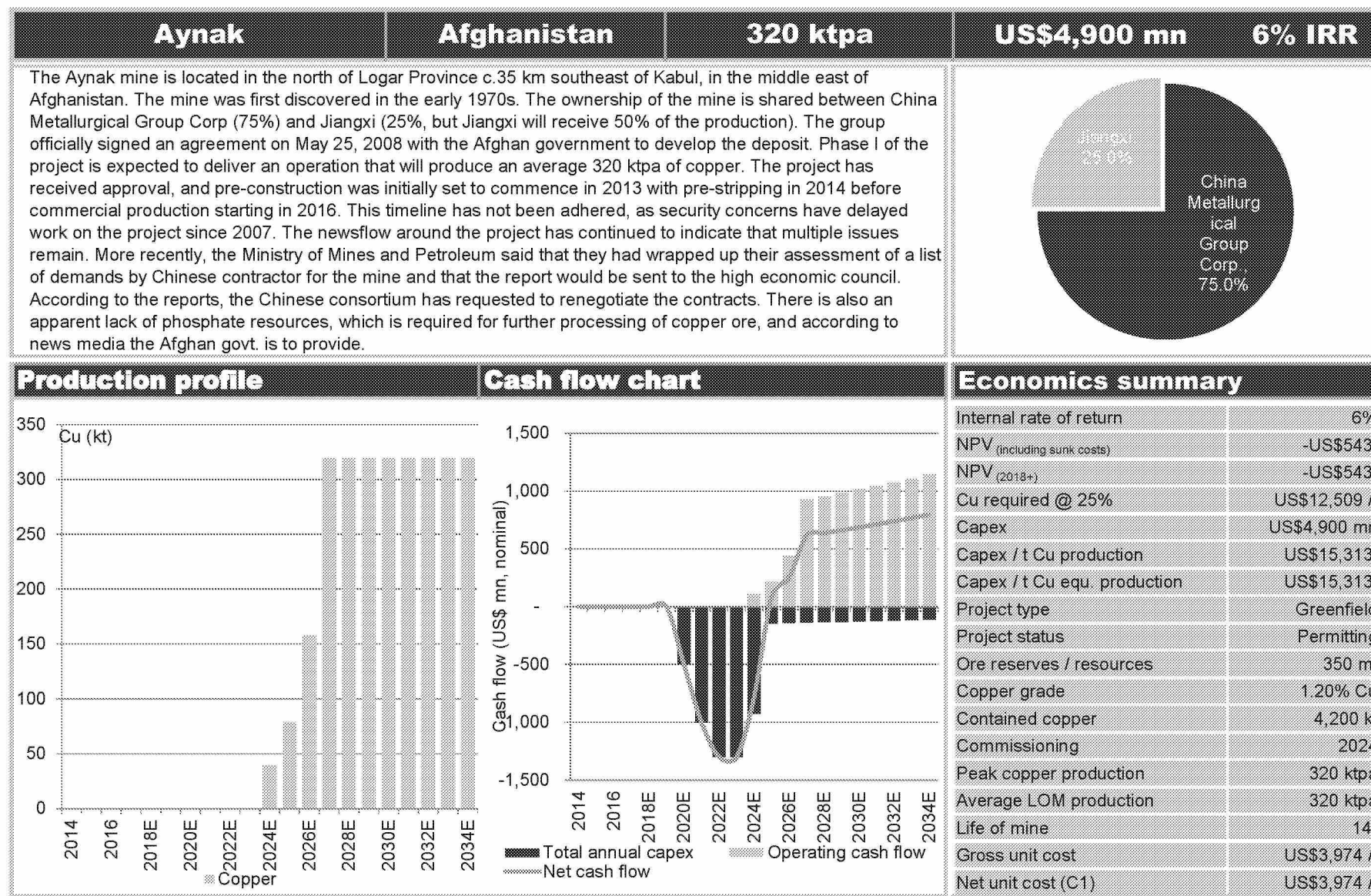
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 90: Asmara



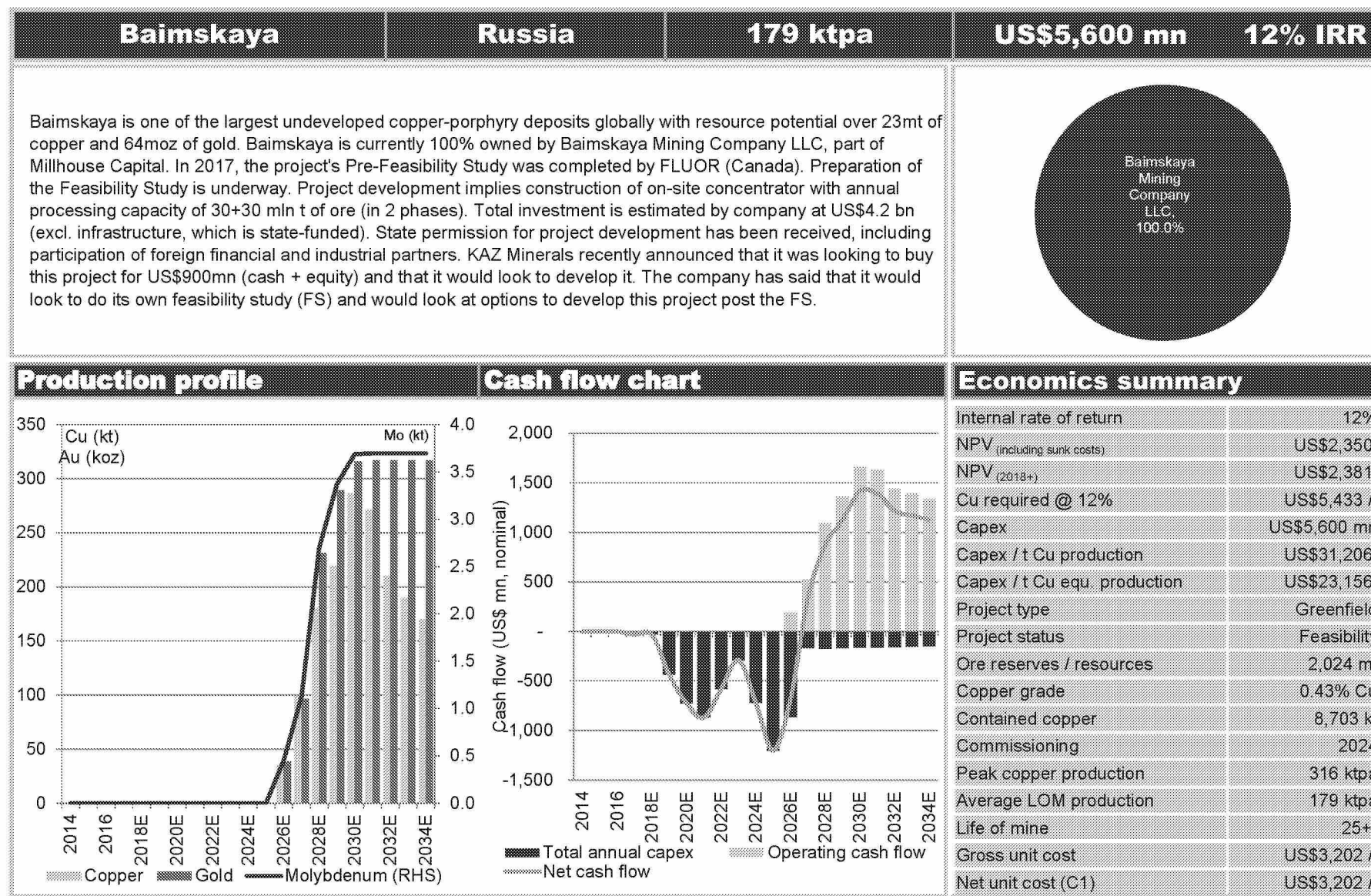
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 91: Aynak



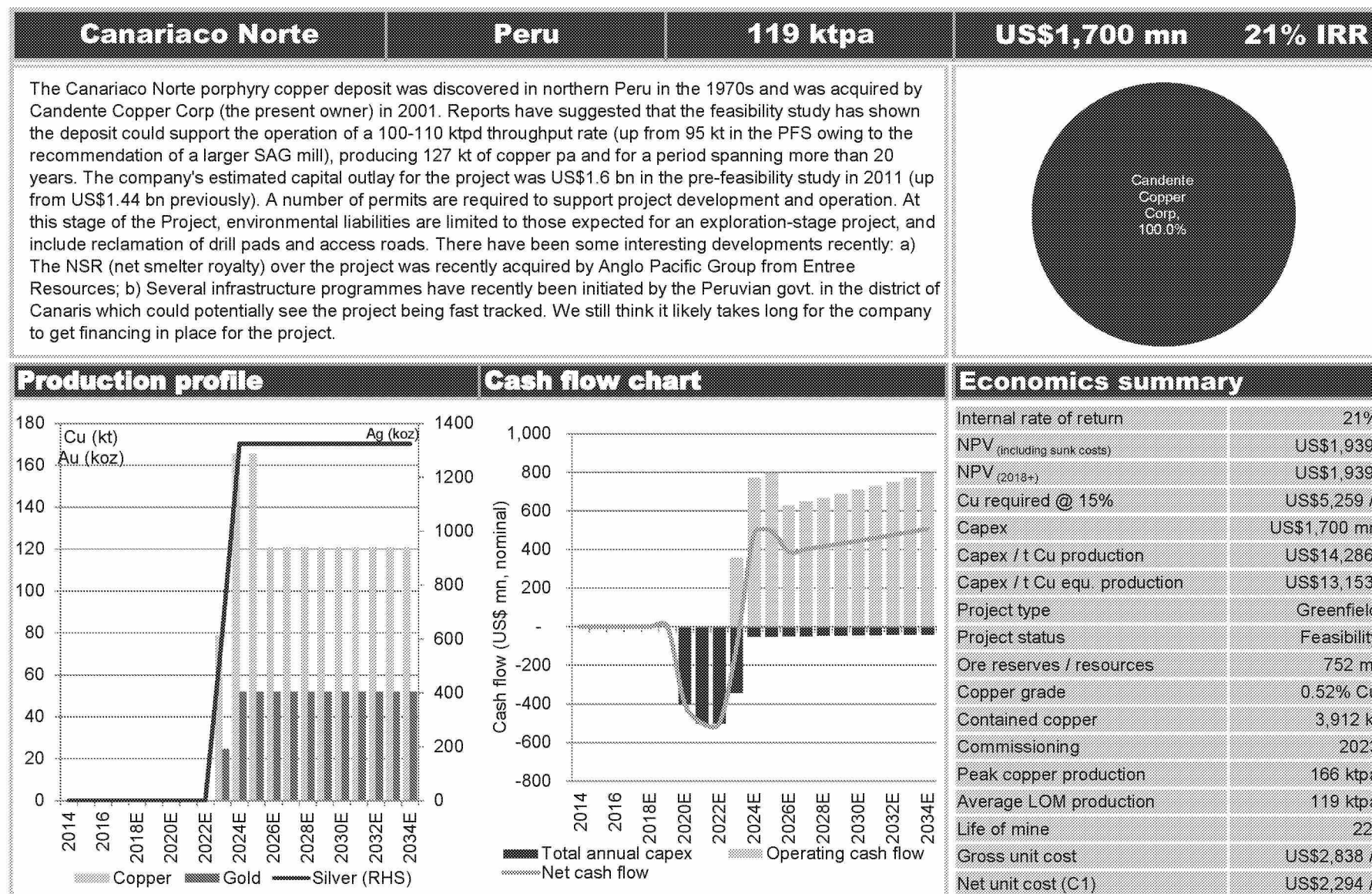
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 92: Baimskaya



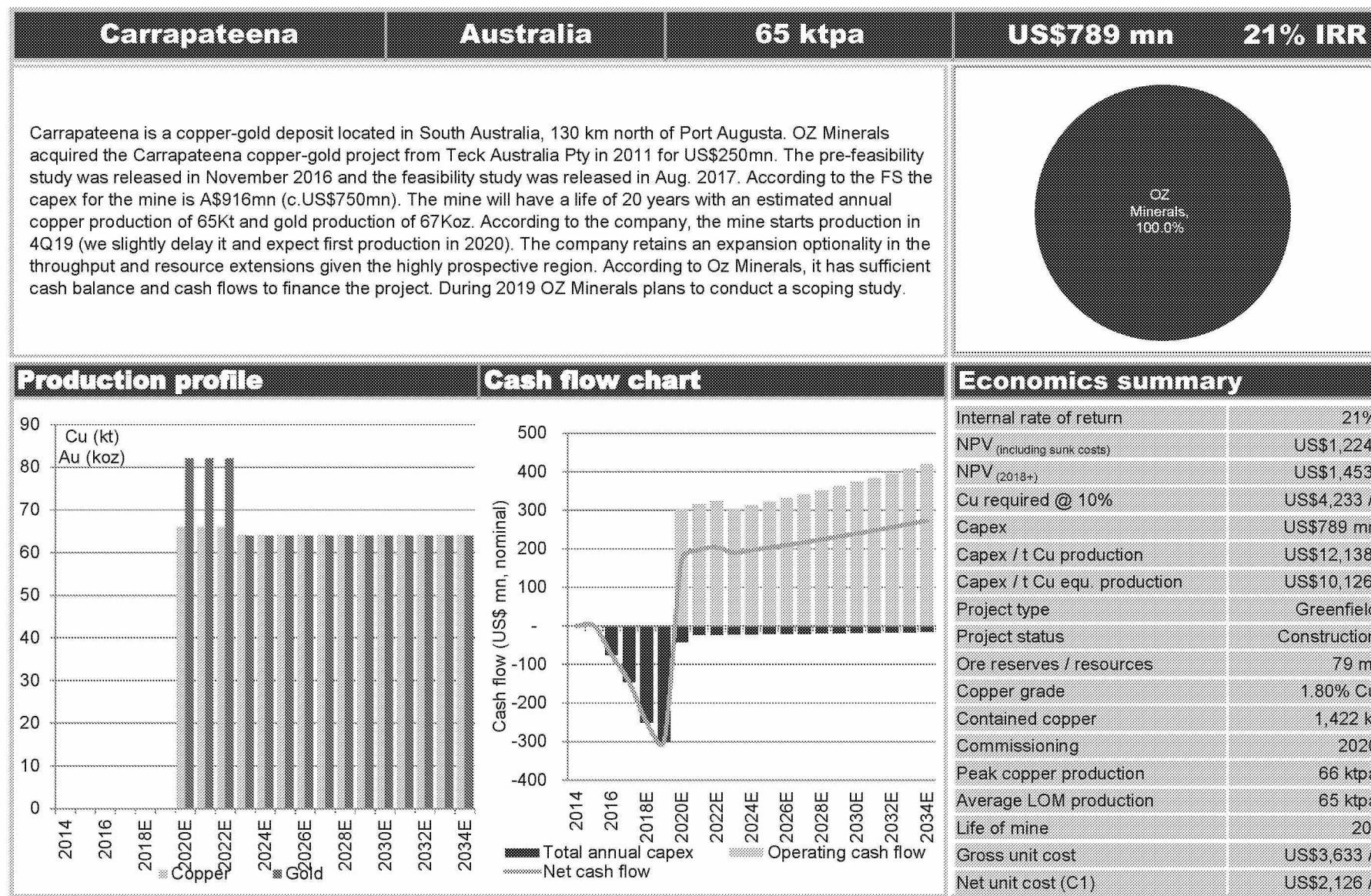
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 93: Canariaco Norte



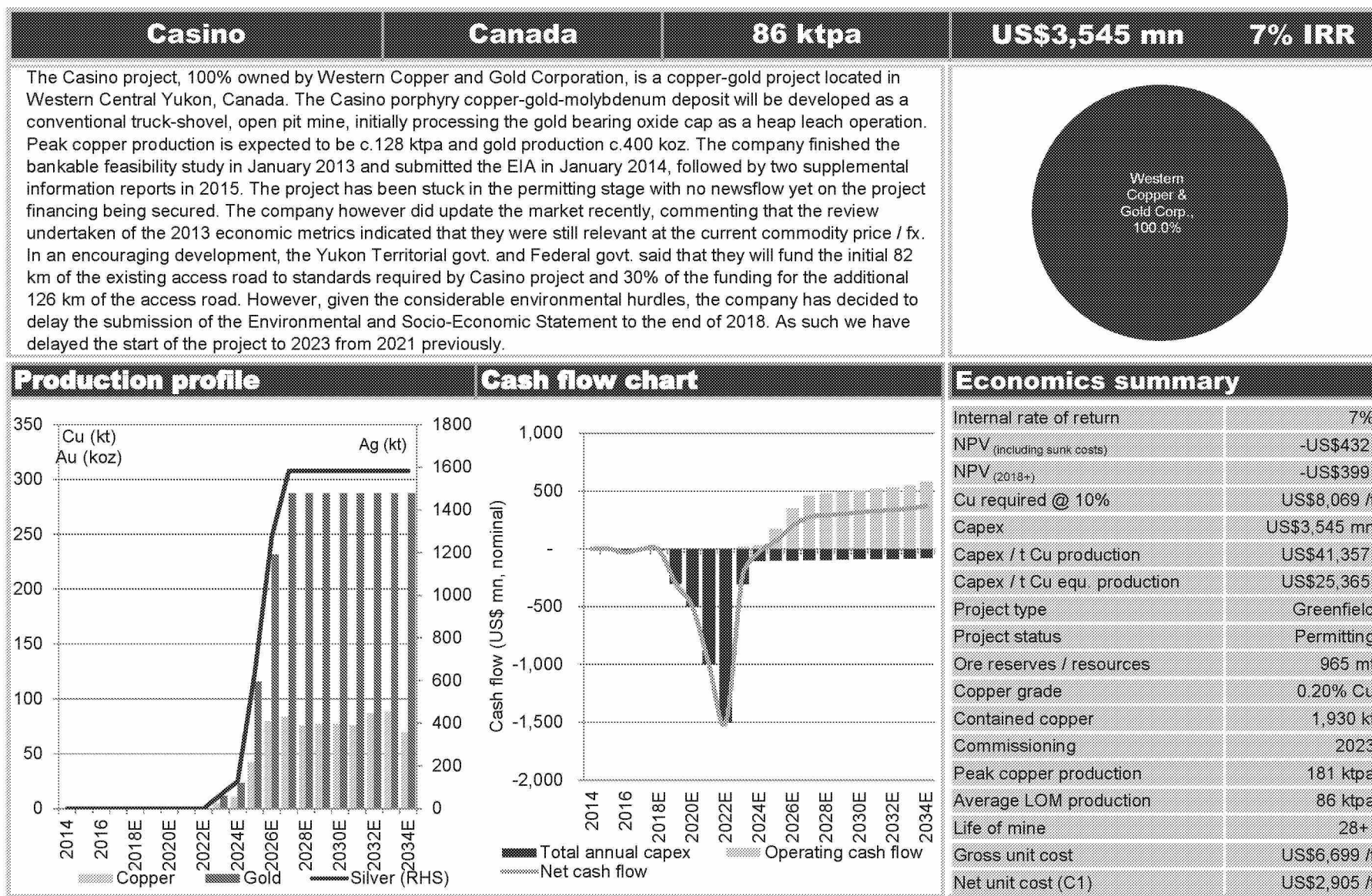
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 94: Carrapateena



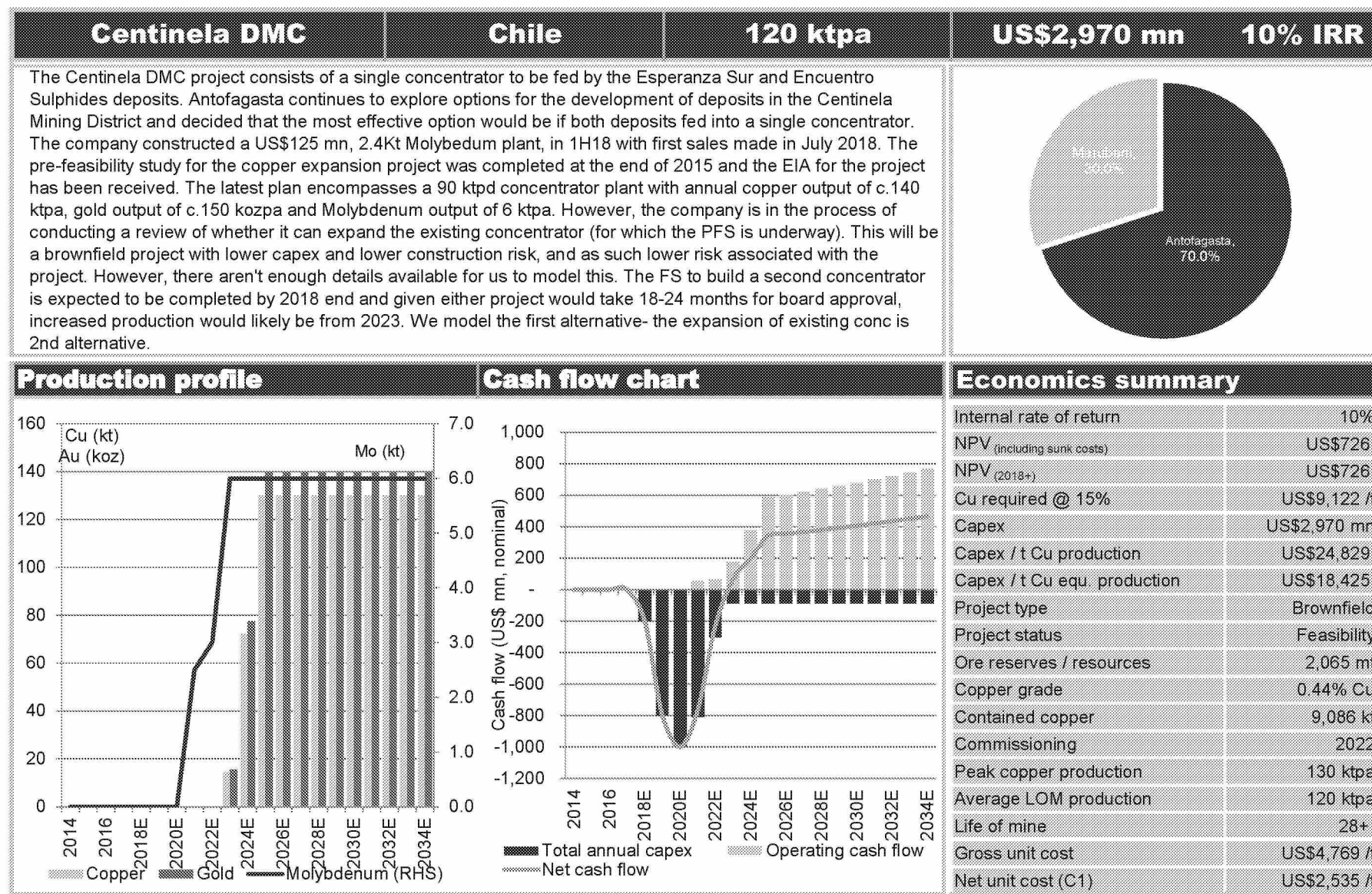
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 95: Casino



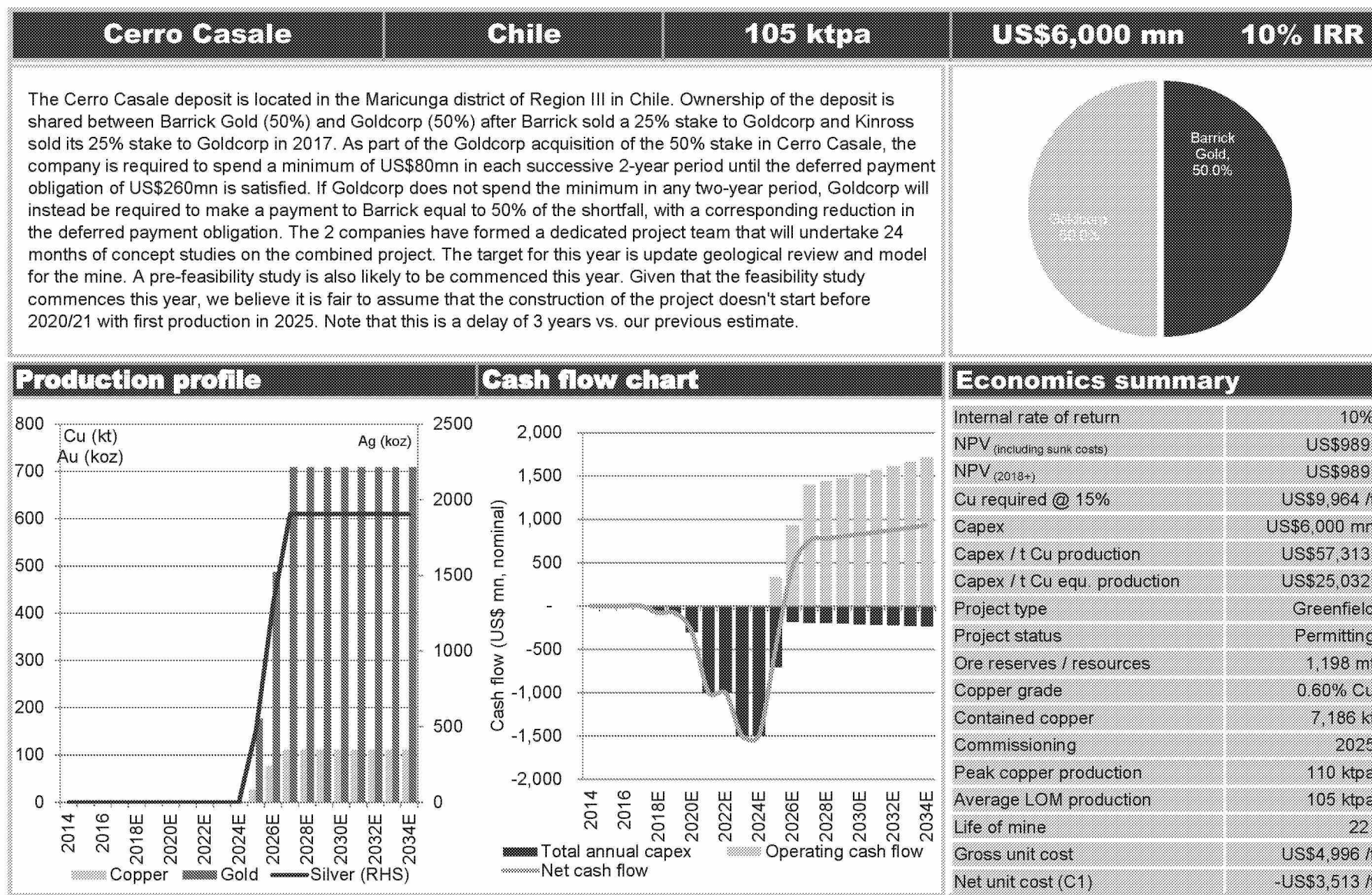
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 96: Centinela DMC



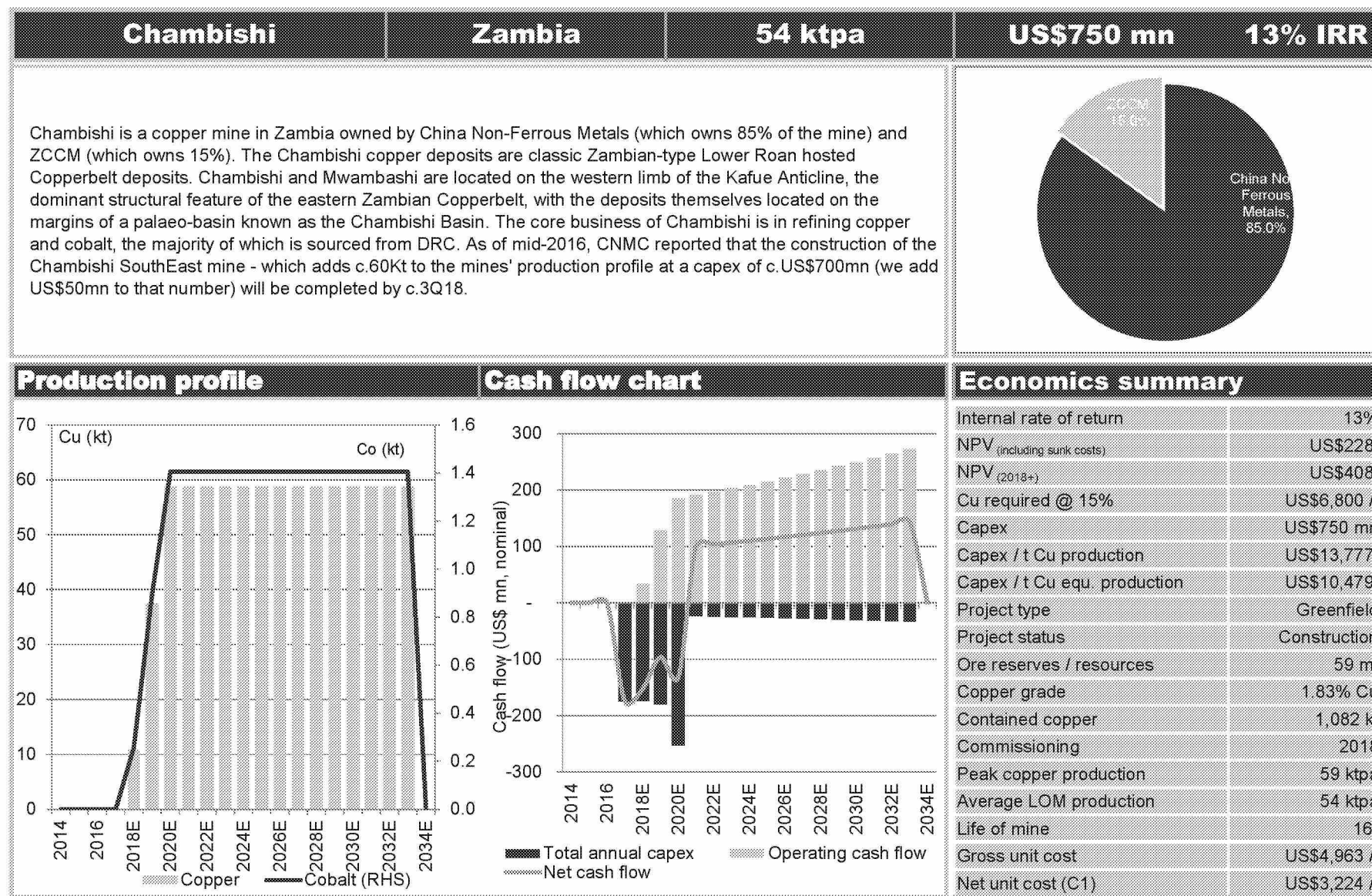
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 97: Cerro Casale



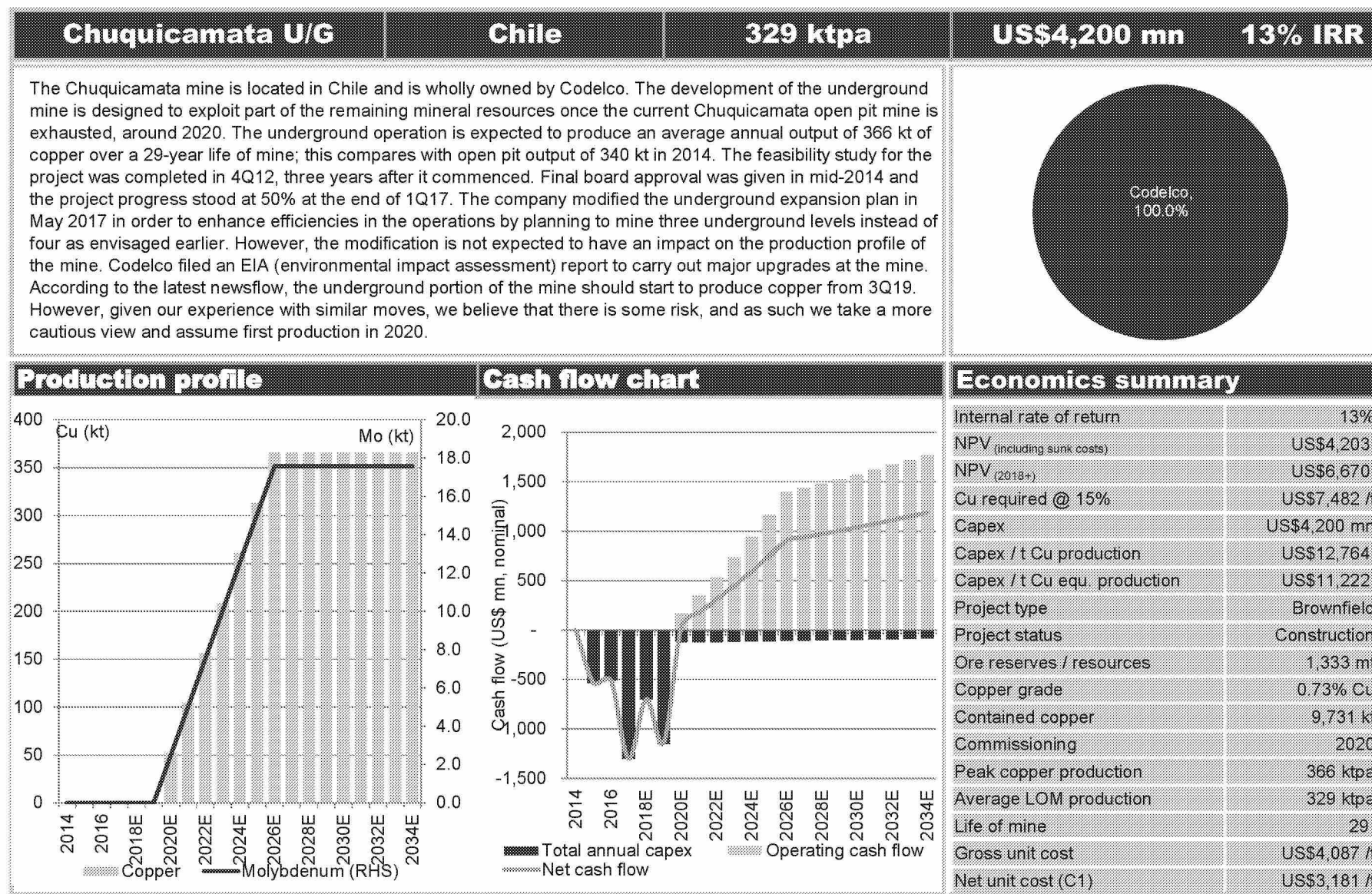
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 98: Chambishi



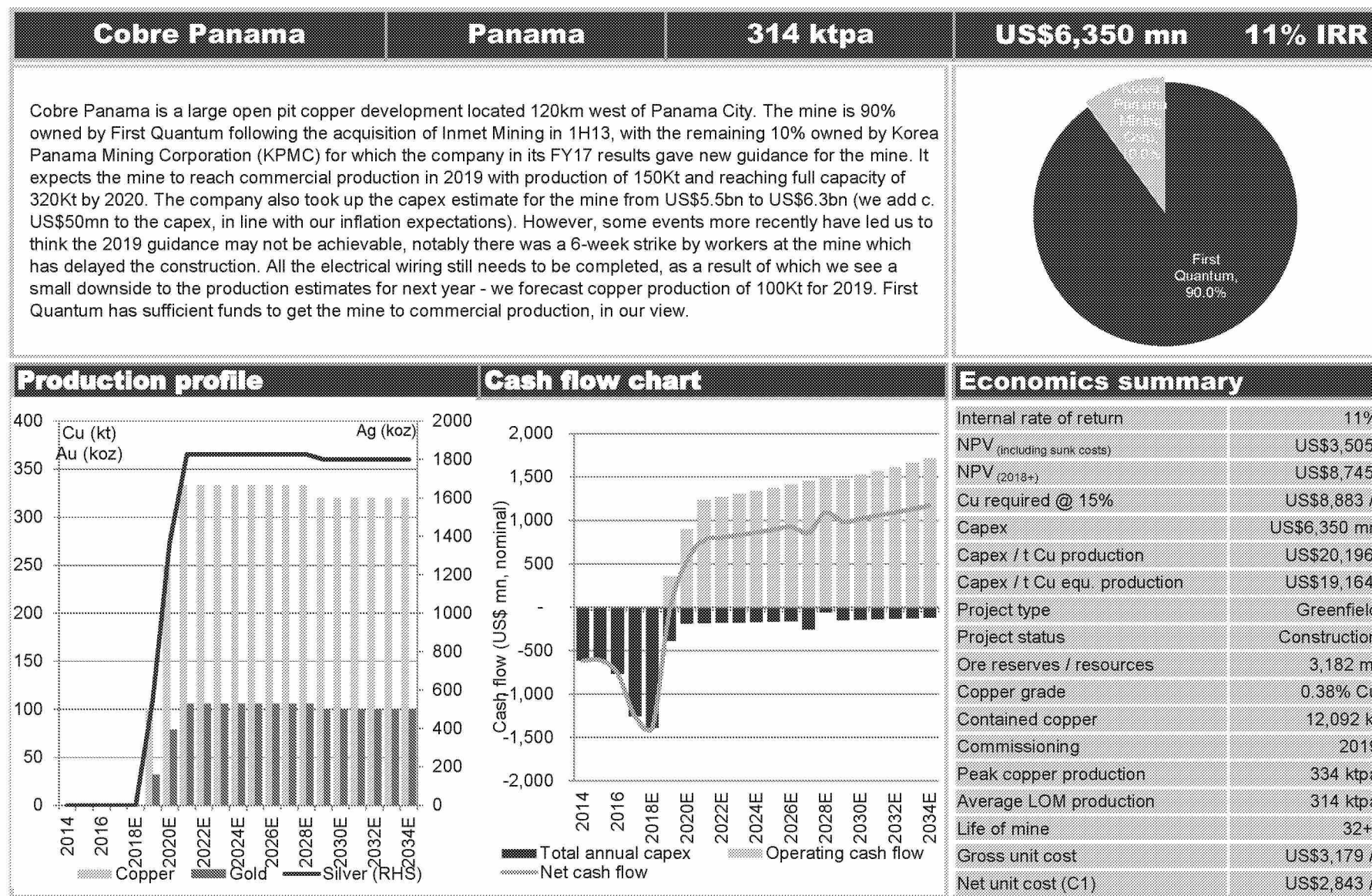
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 99: Chuquicamata U/G



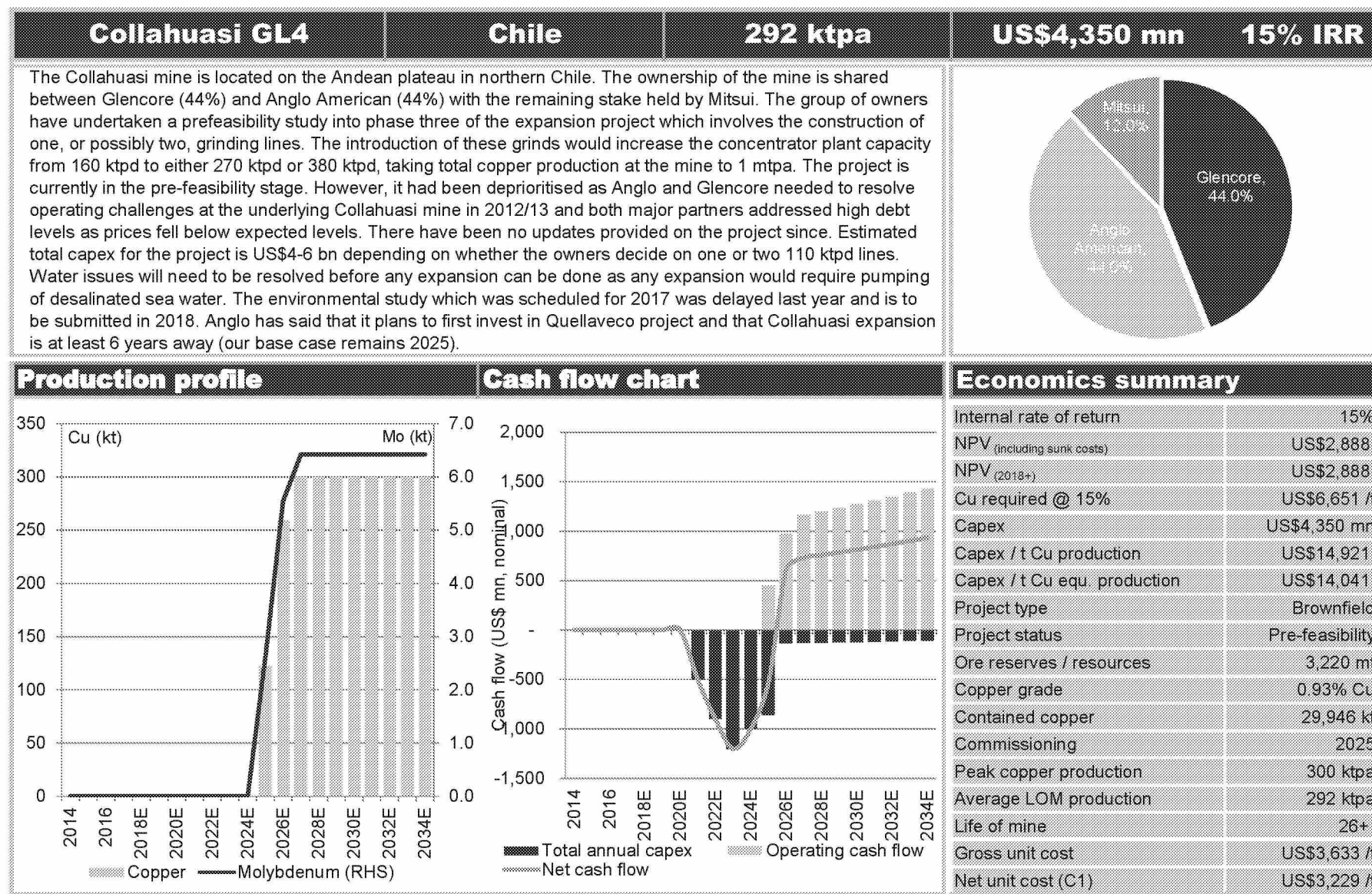
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 100: Cobre Panama



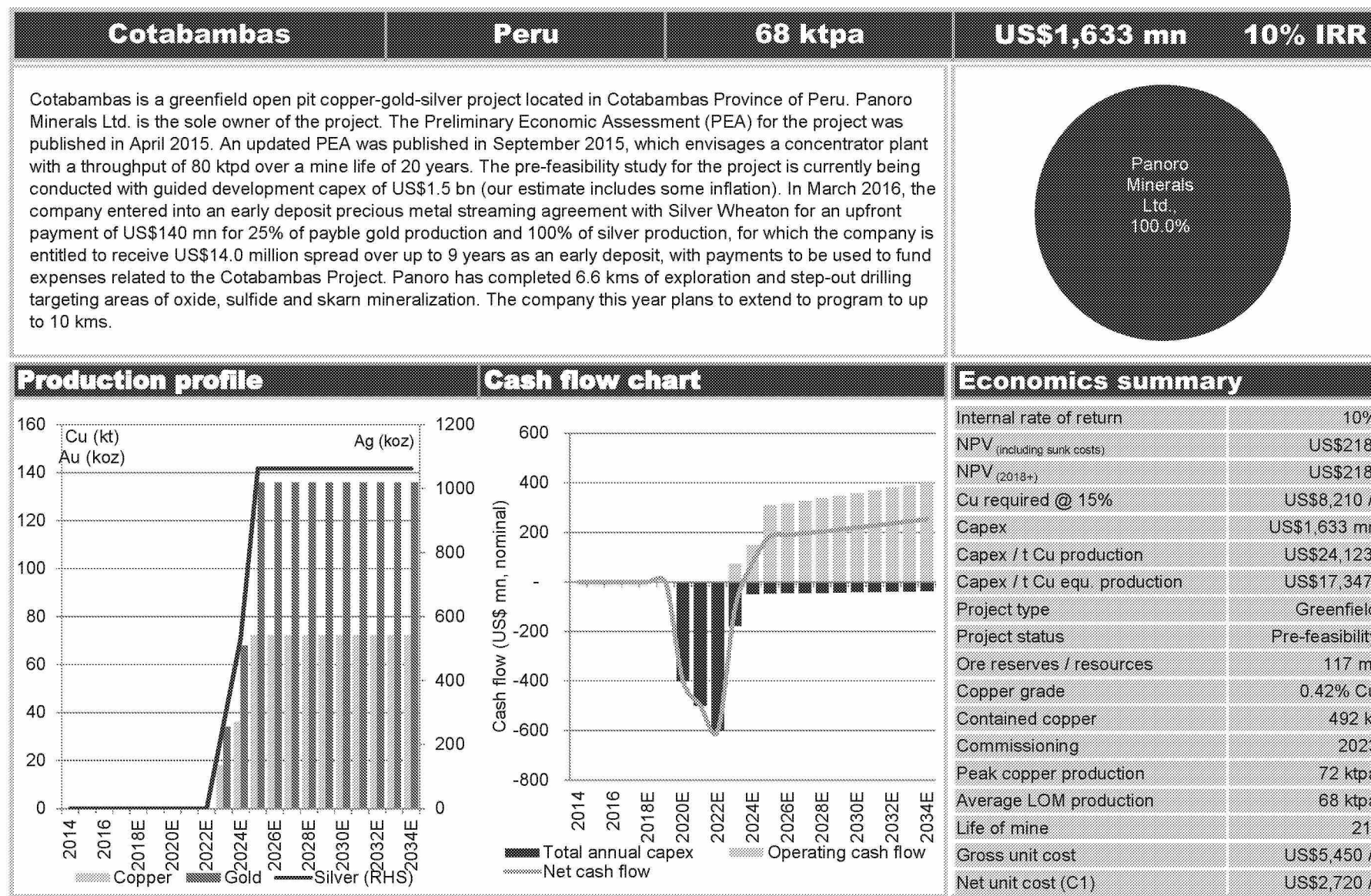
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 101: Collahuasi GL4



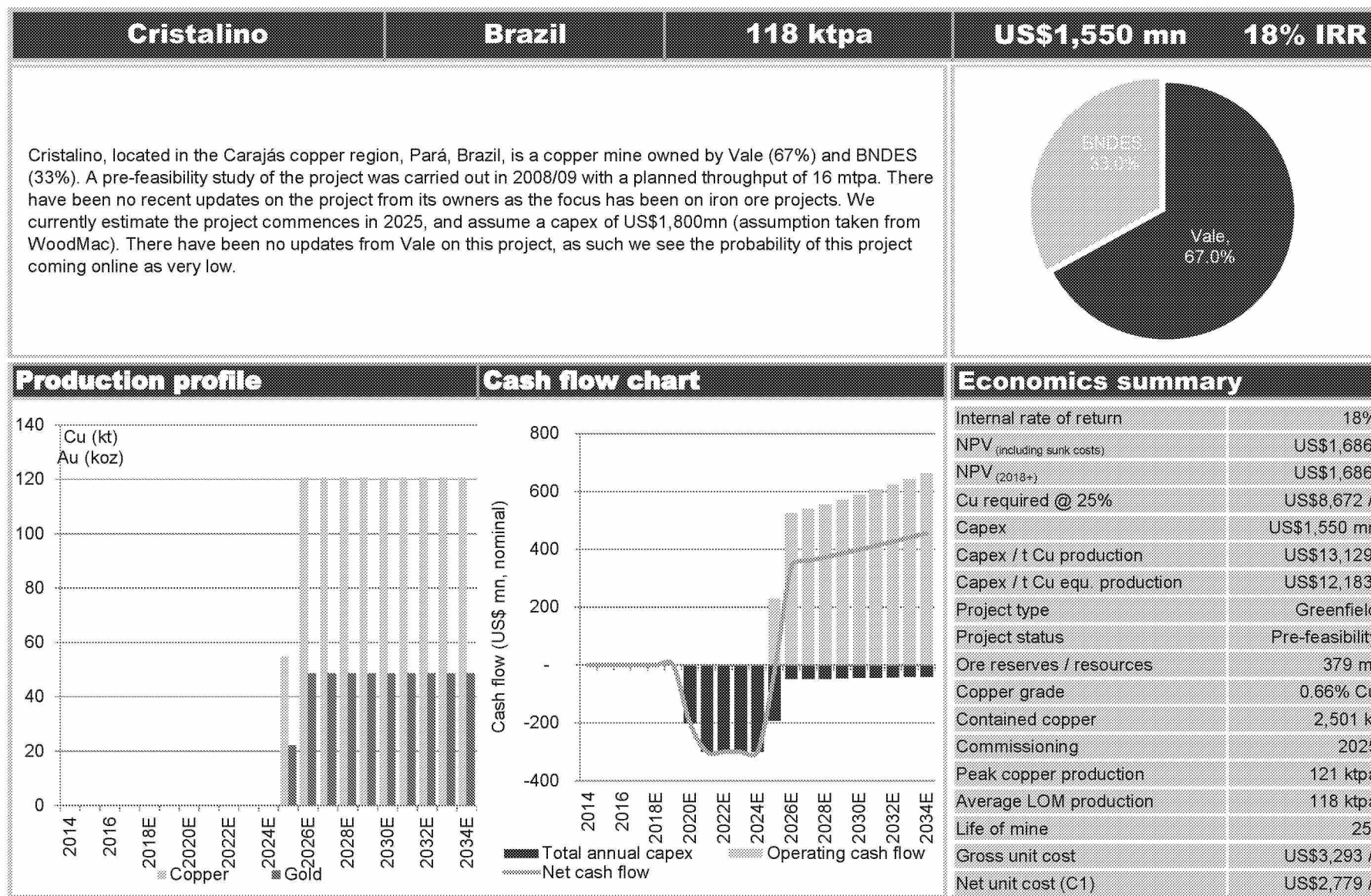
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 102: Cotabambas



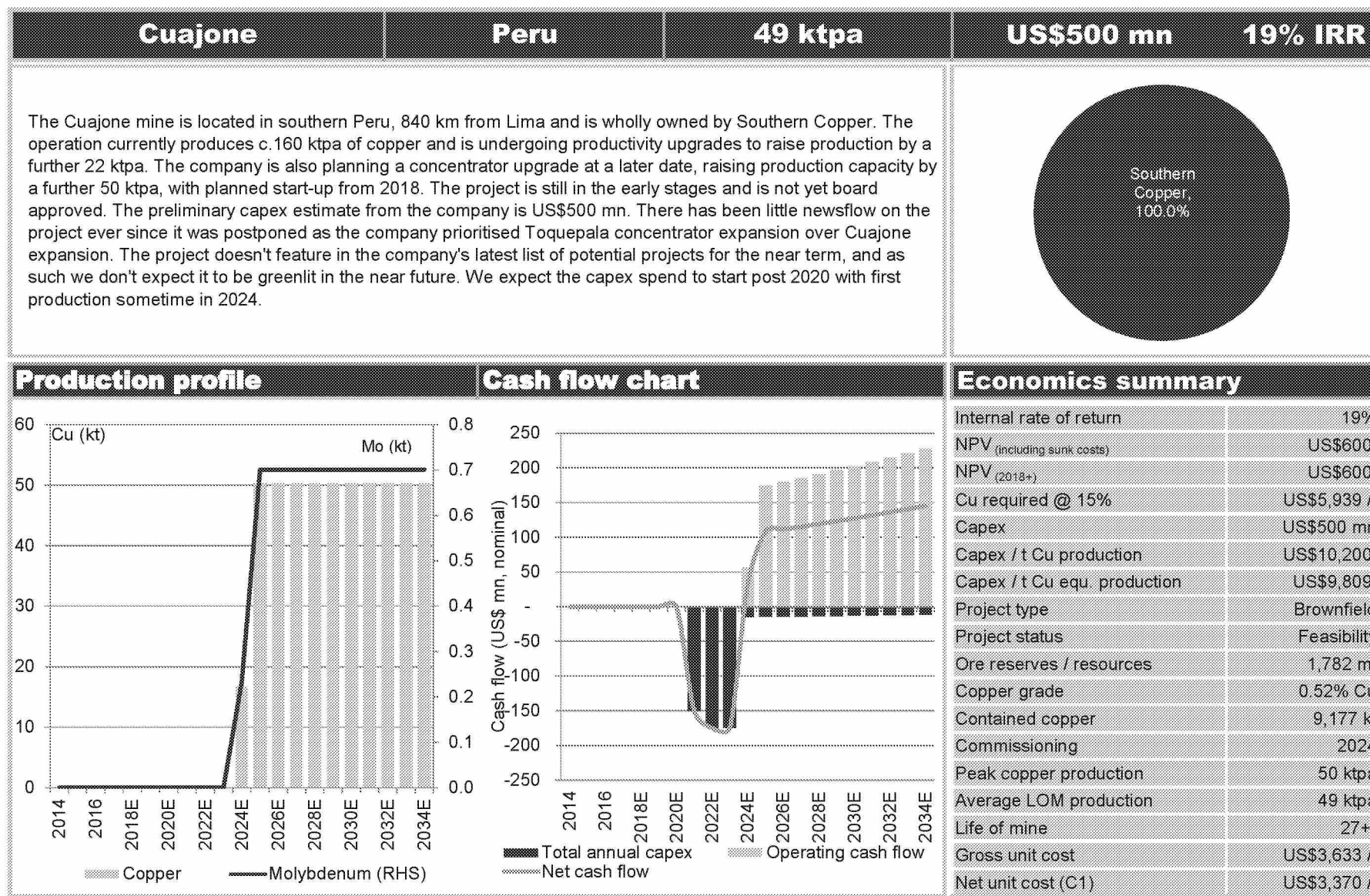
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 103: Cristalino



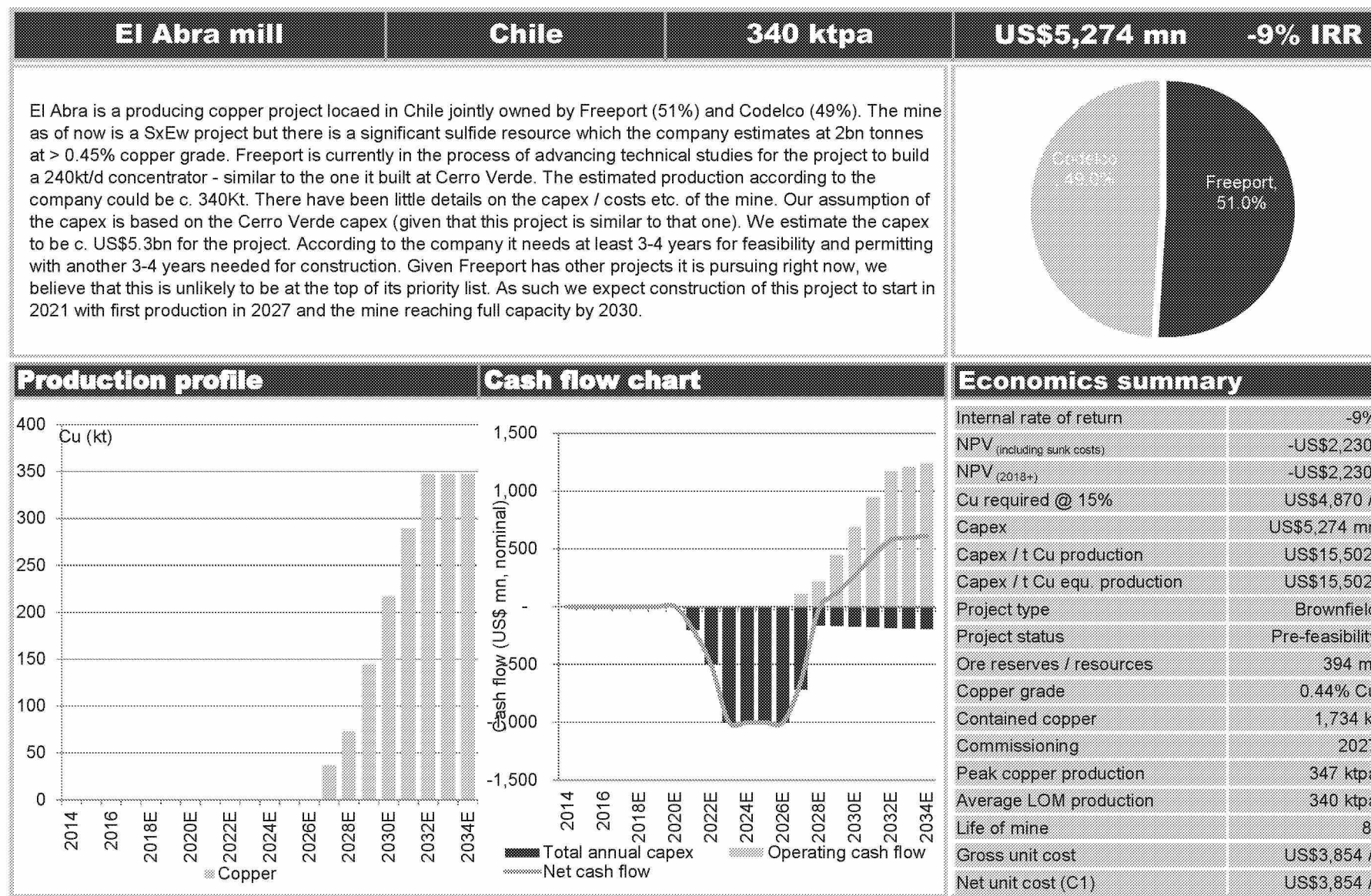
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 104: Cuaajone



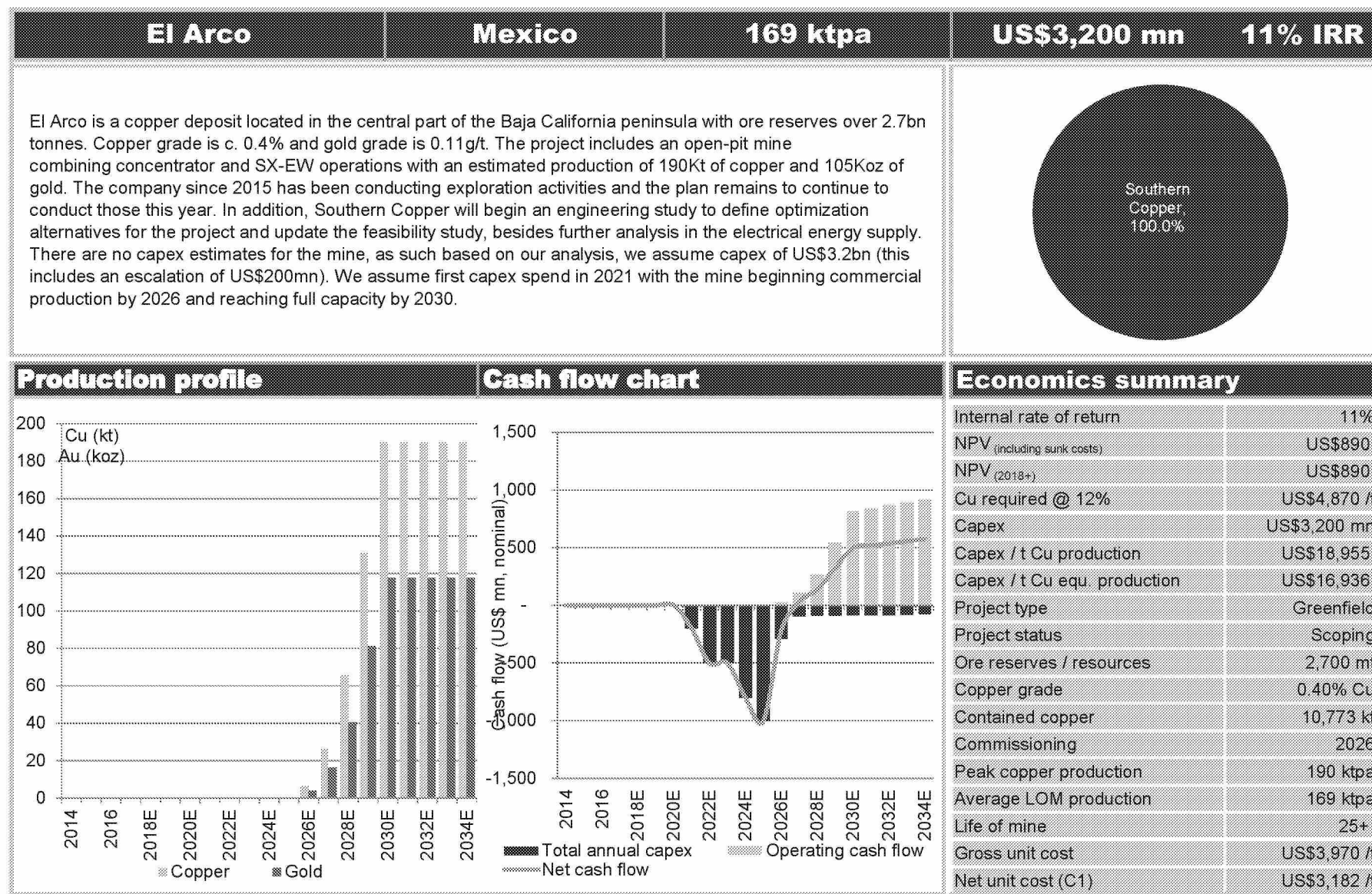
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 105: El Abra



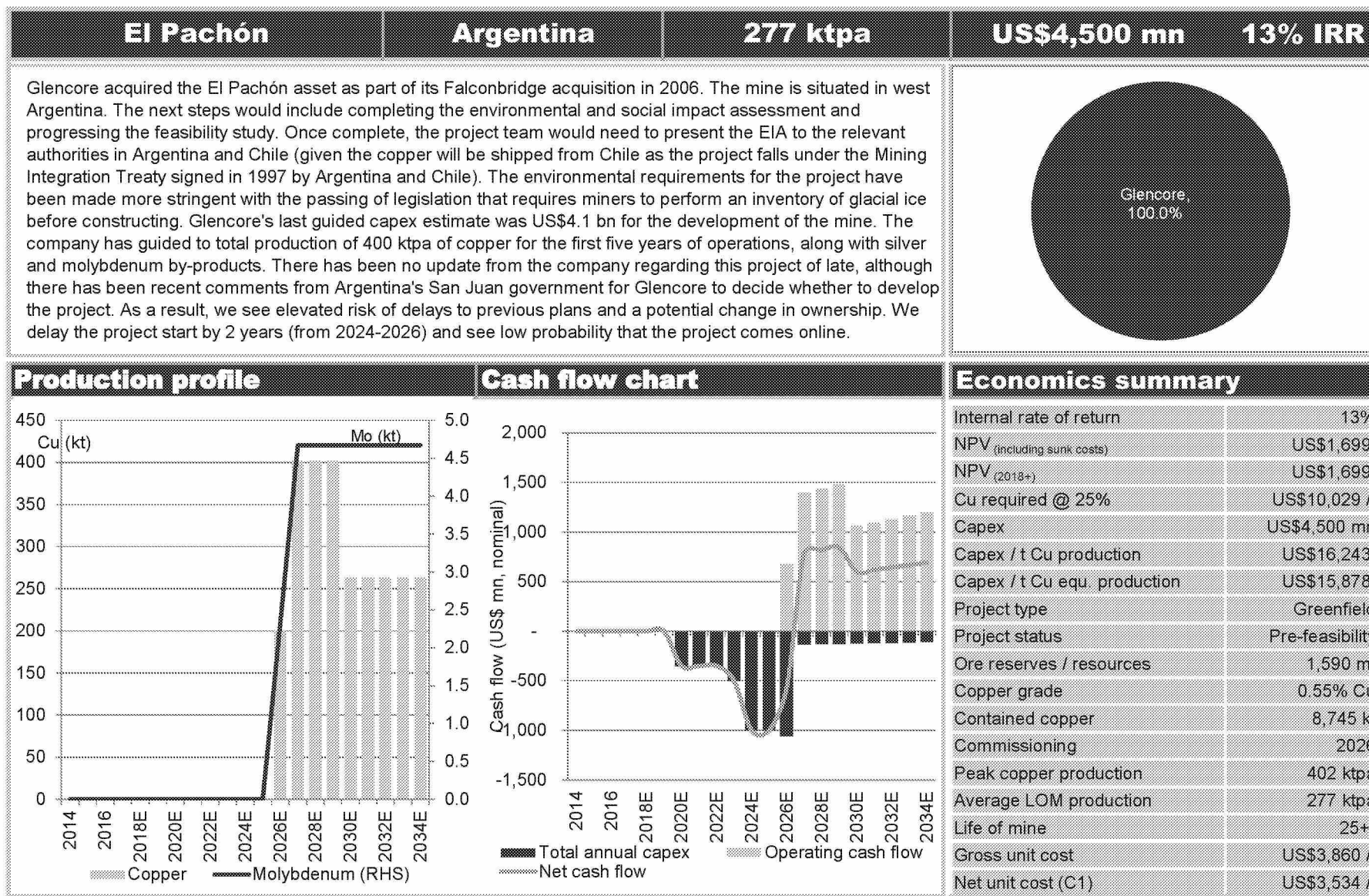
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 106: El Arco



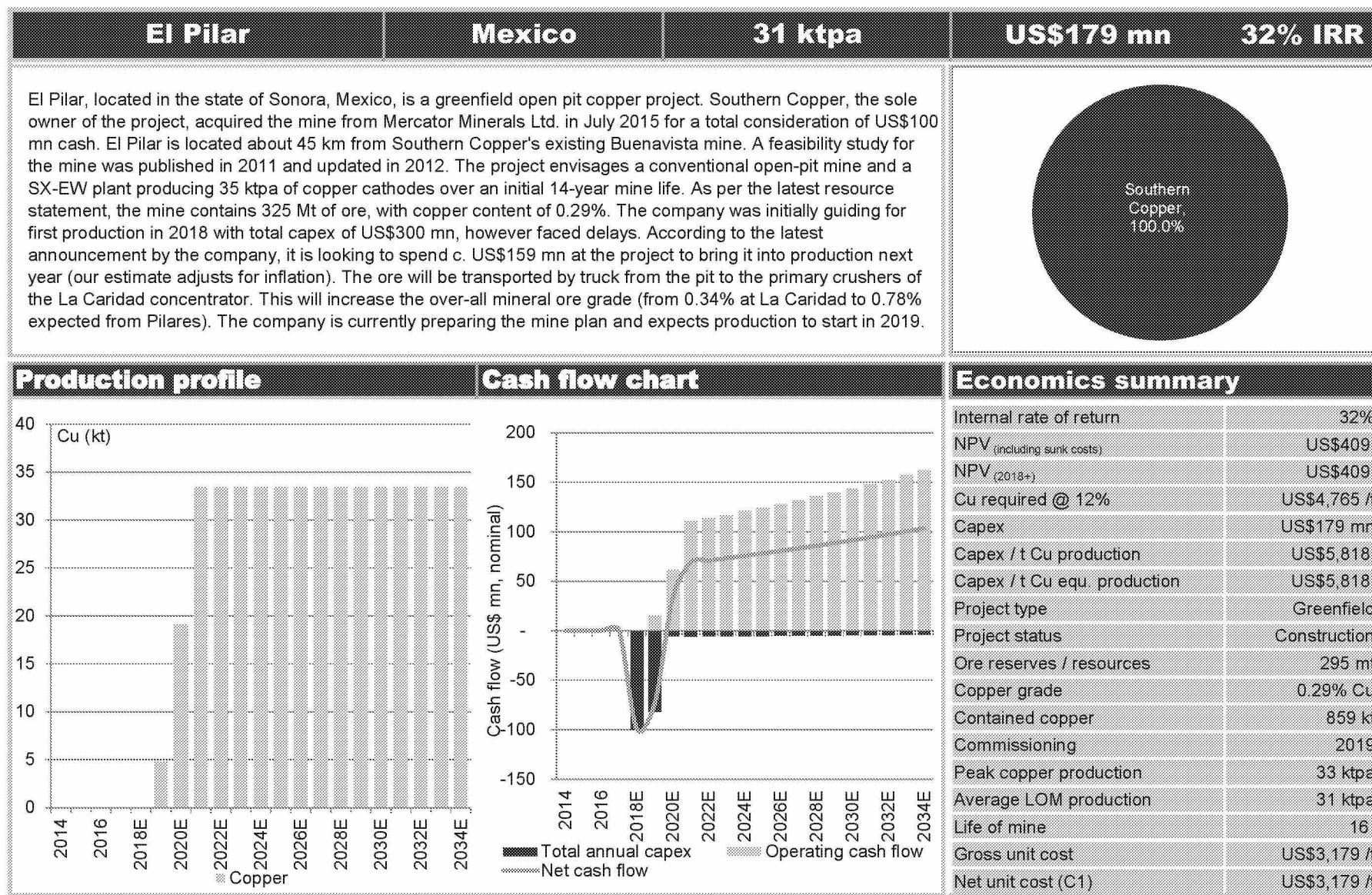
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 107: El Pachon



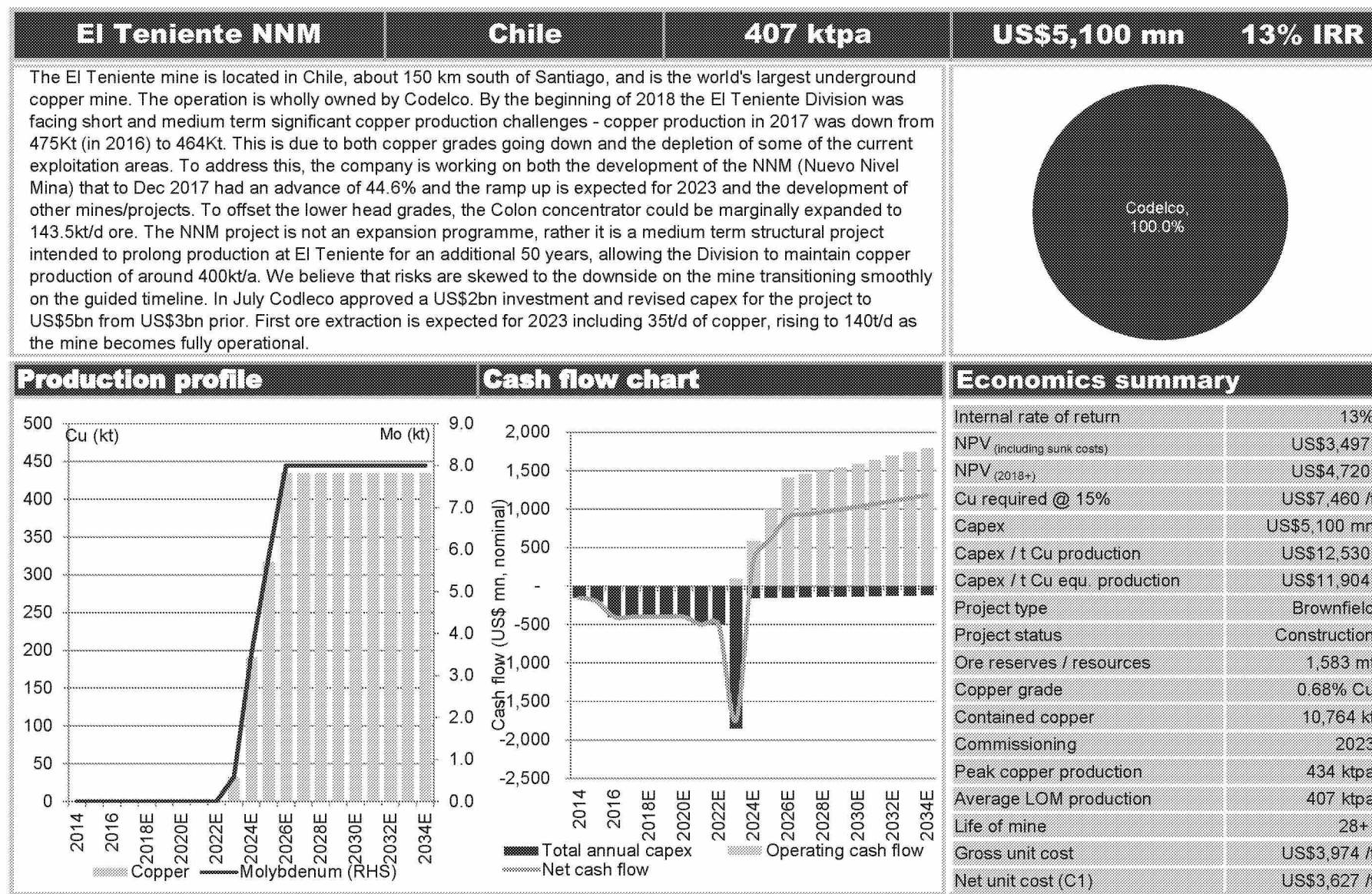
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 108: El Pilar



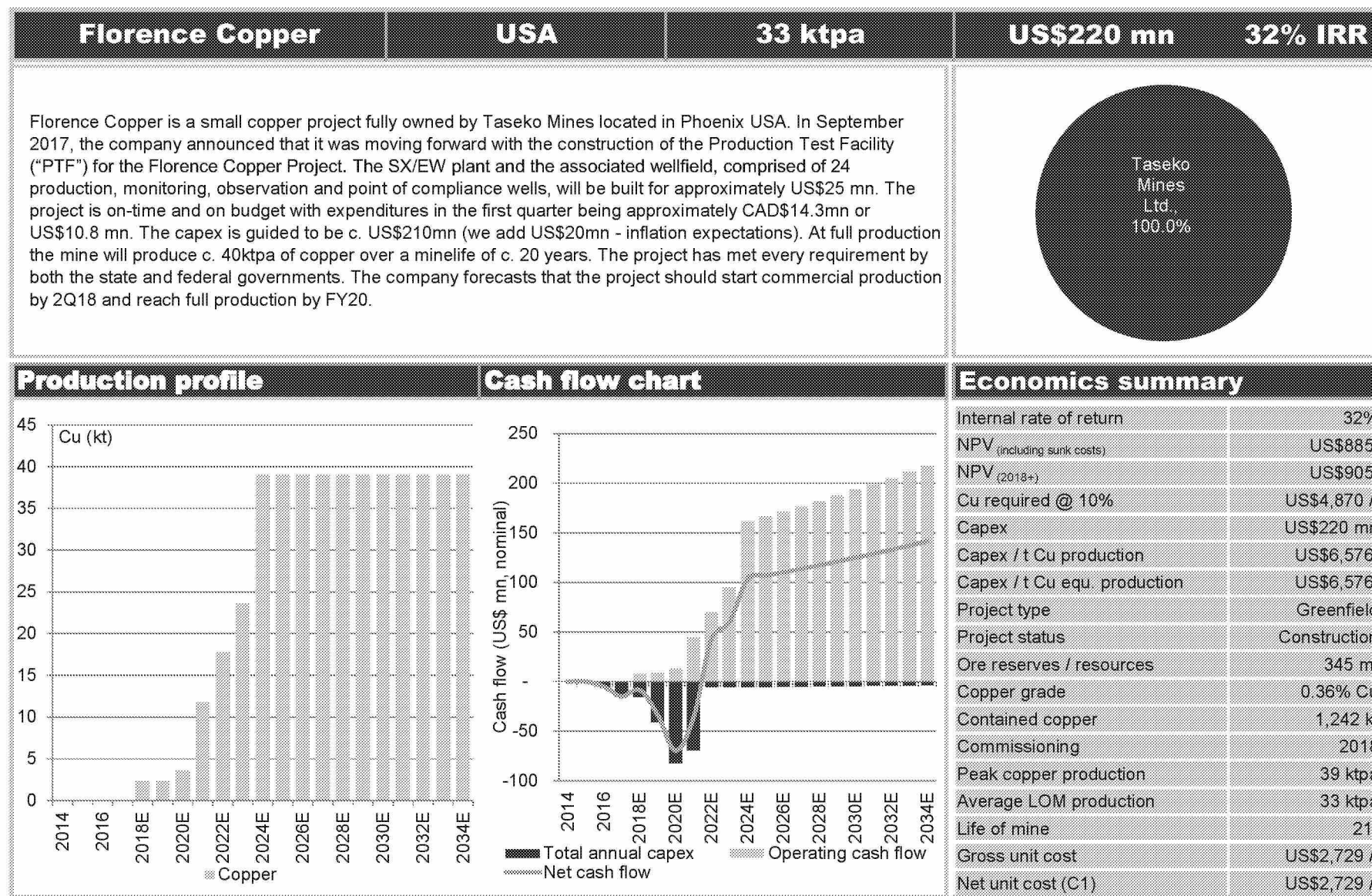
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 109: El Teniente NNM



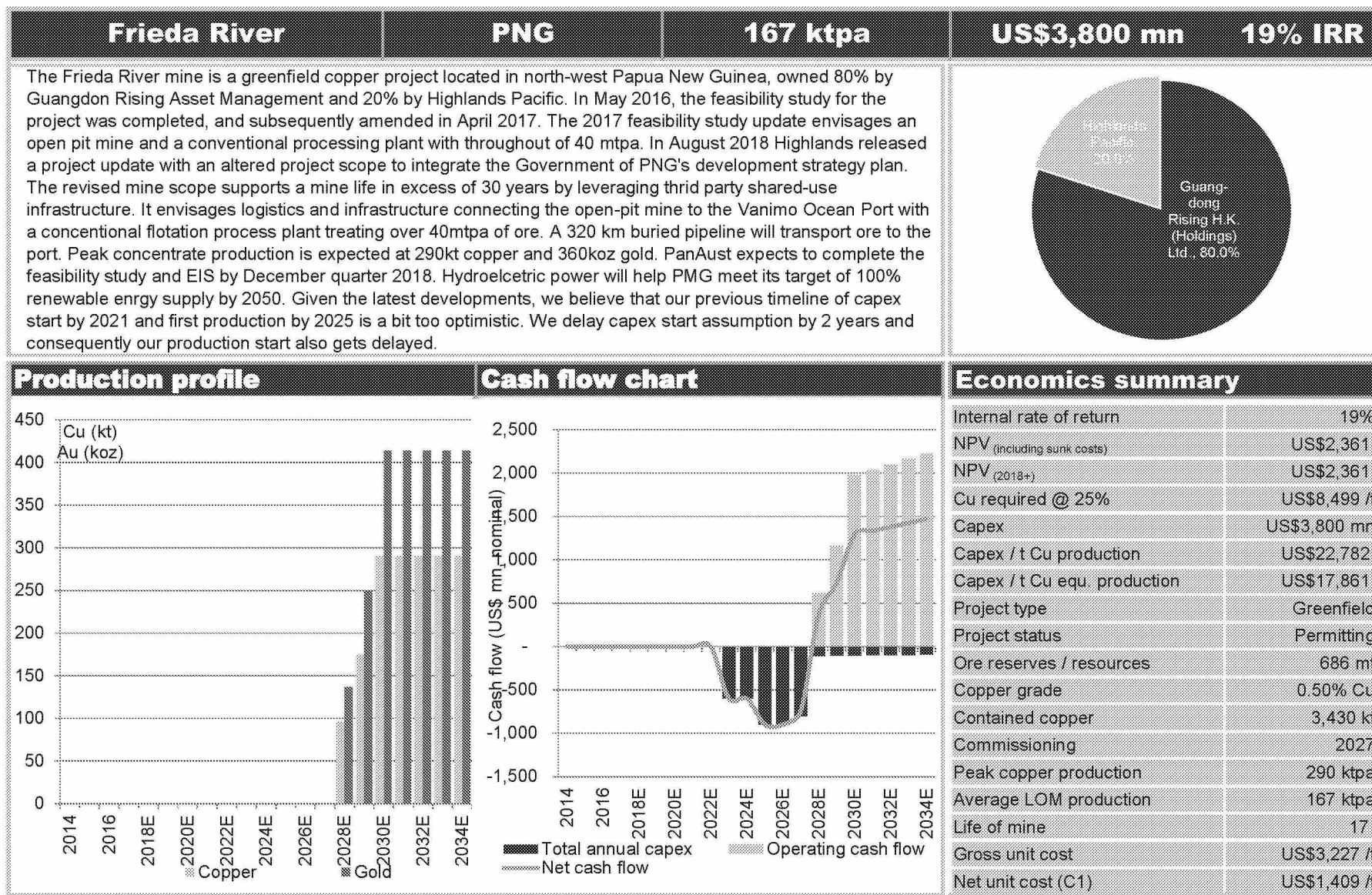
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 110: Florence Copper



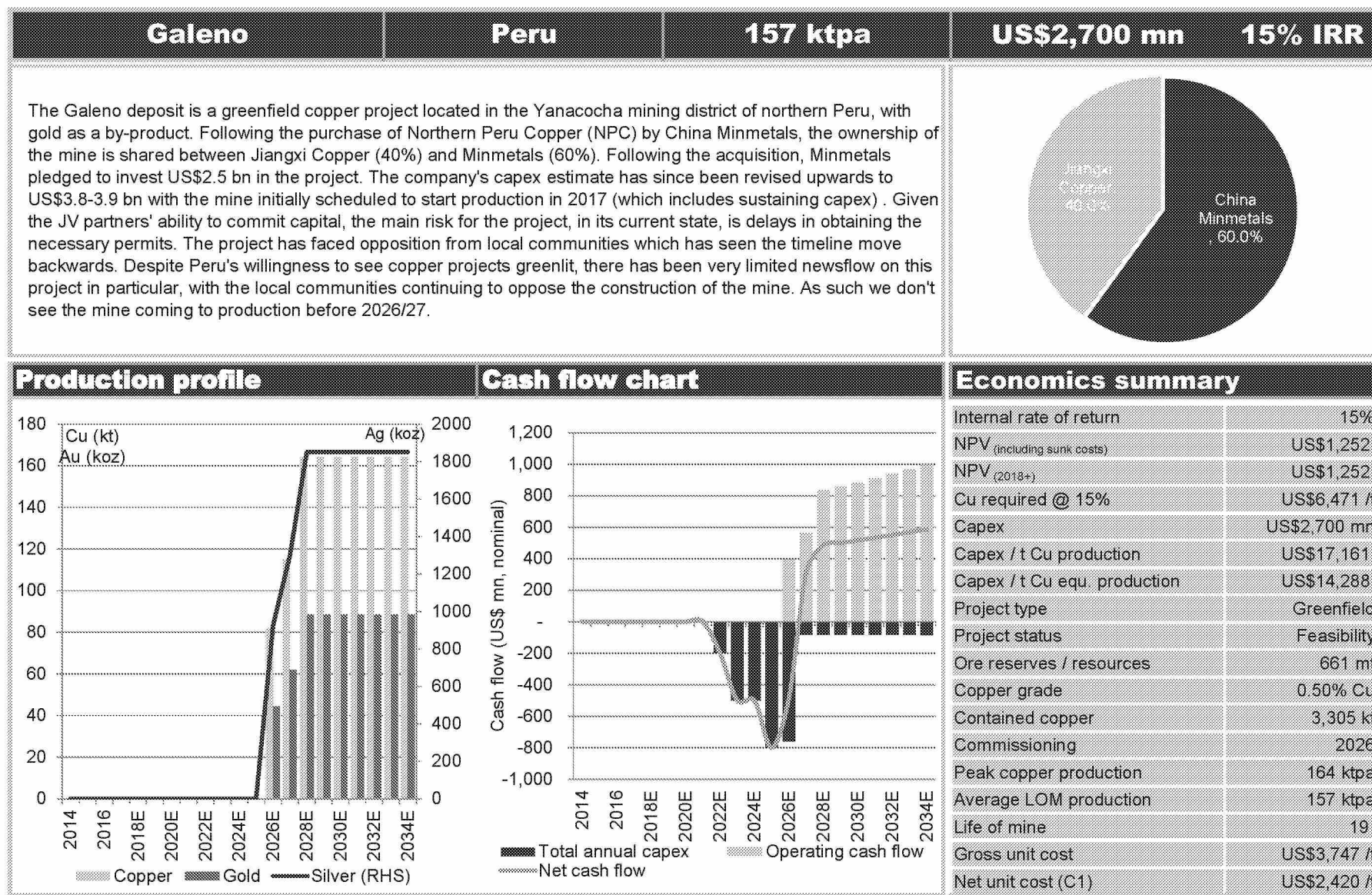
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 111: Frieda River



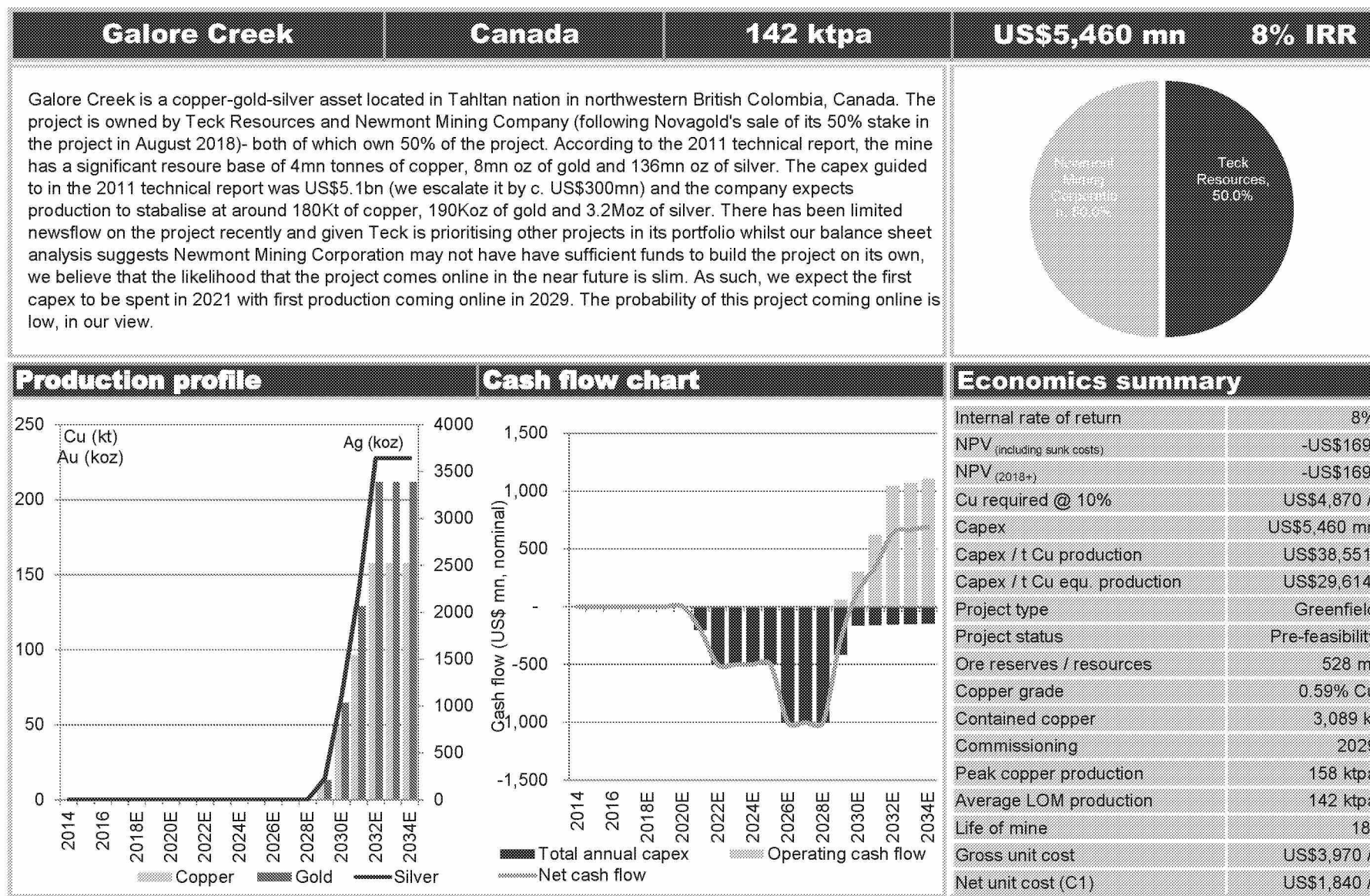
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 112: Galeno



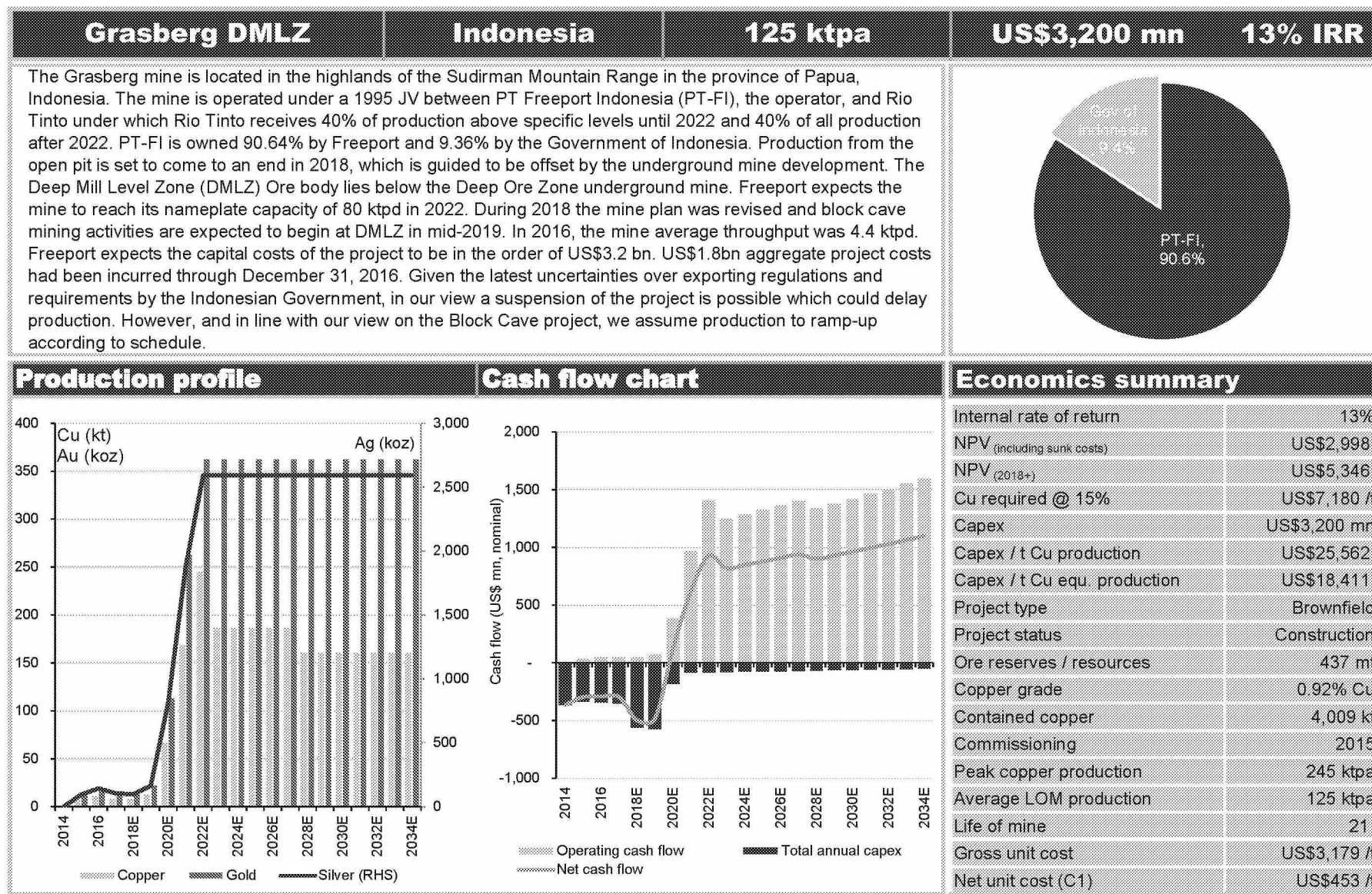
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 113: Galore Creek



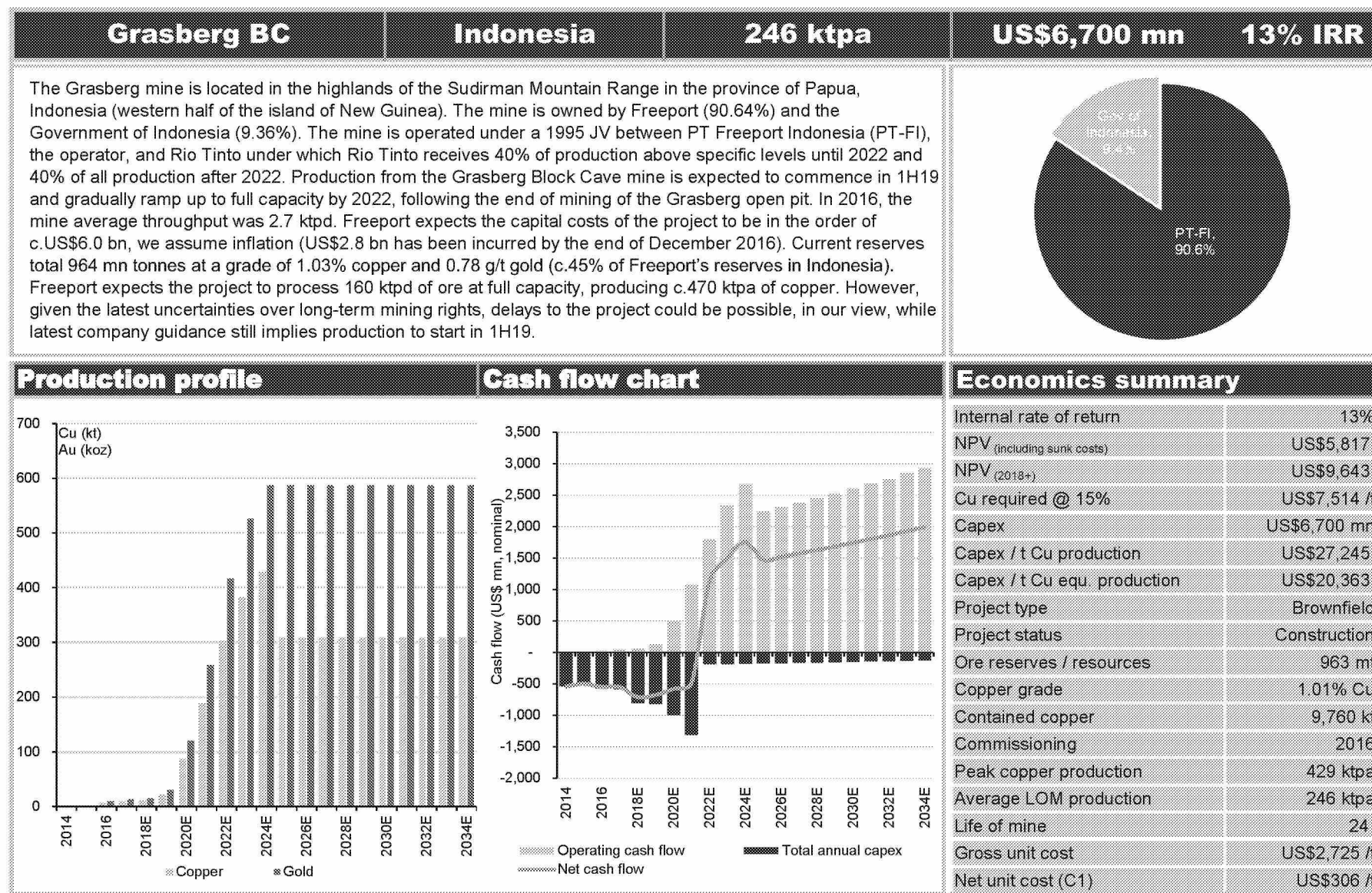
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 114: Grasberg DMLZ



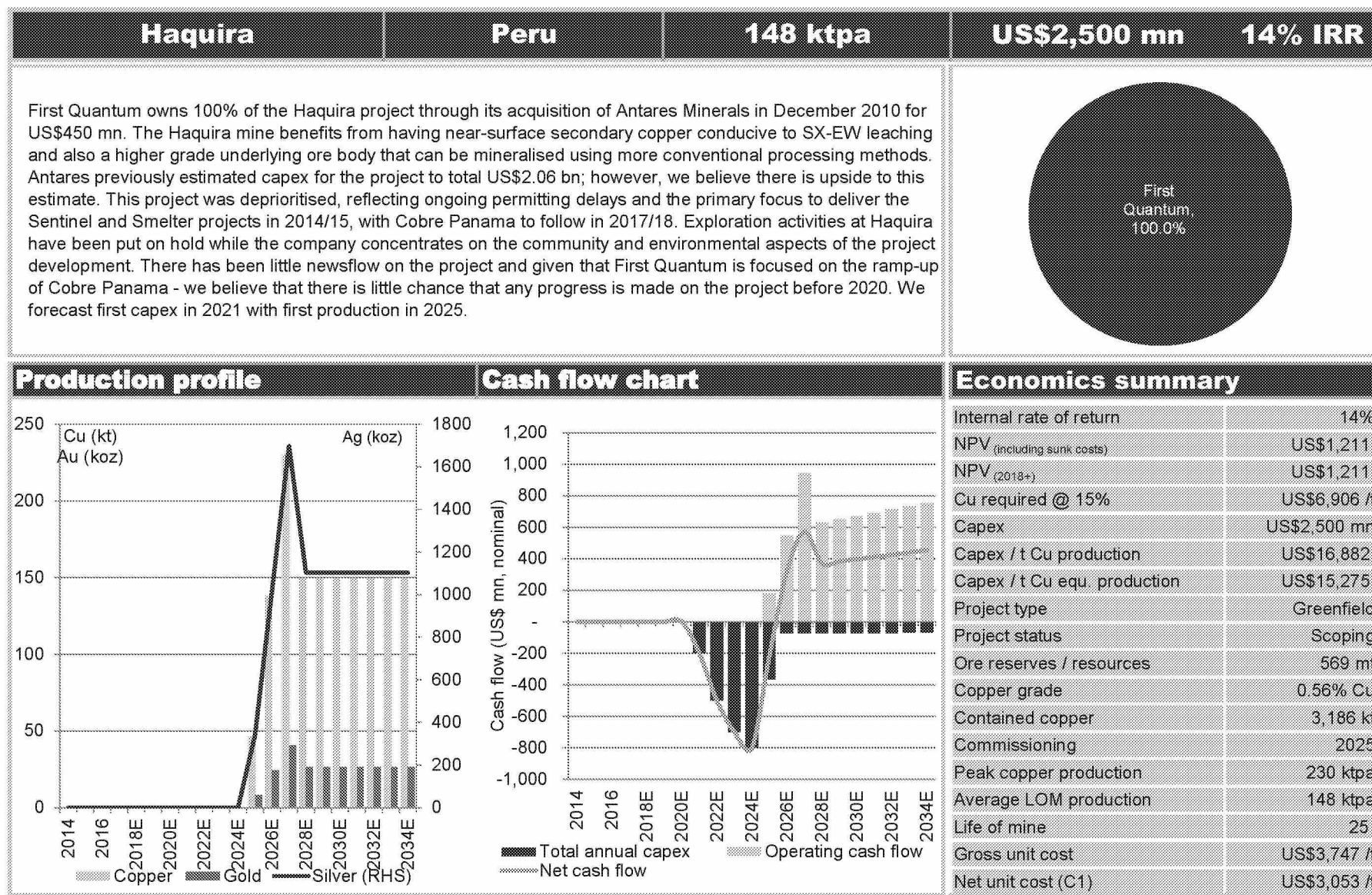
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 115: Grasberg BC



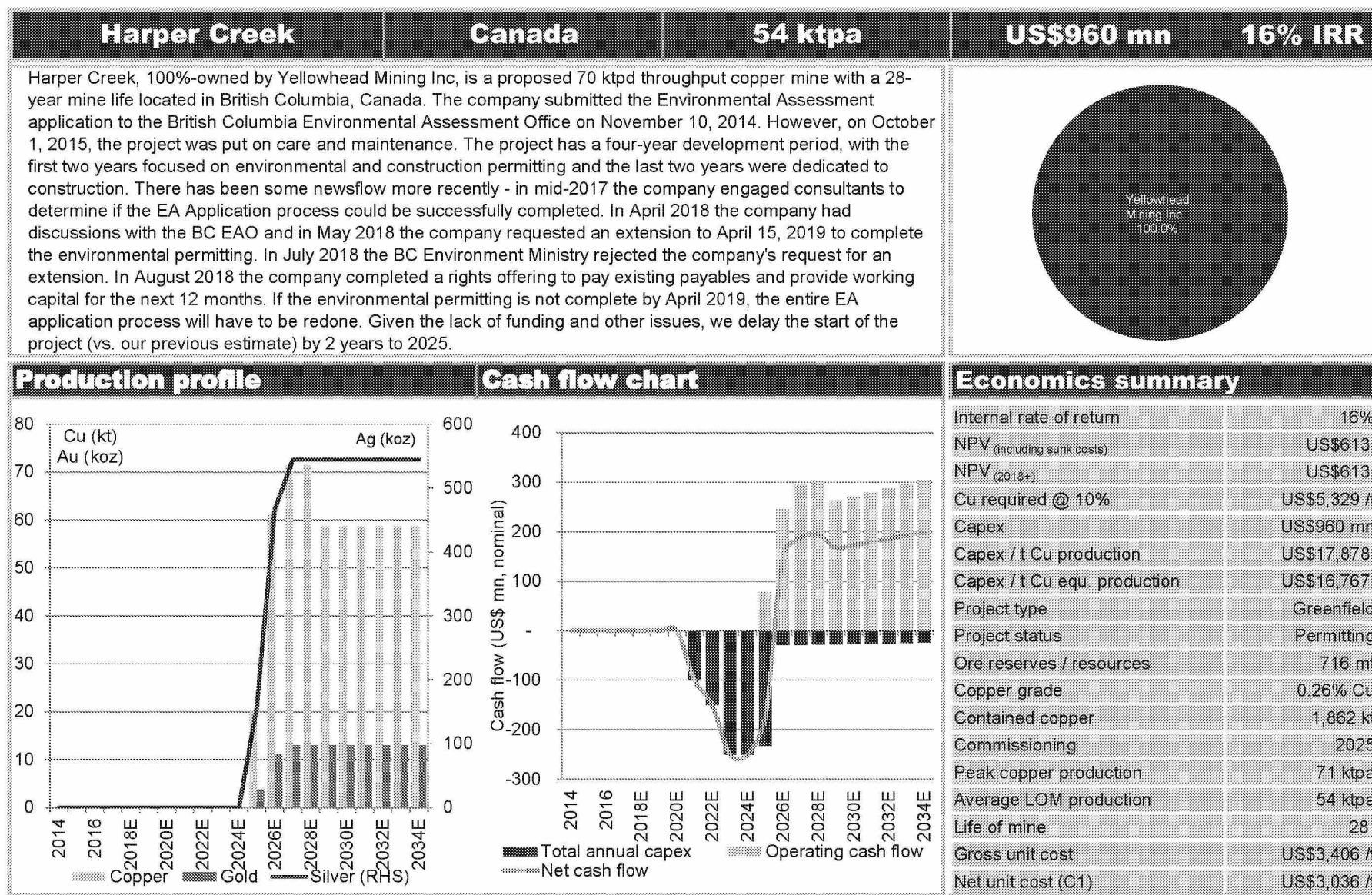
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 116: Haquira



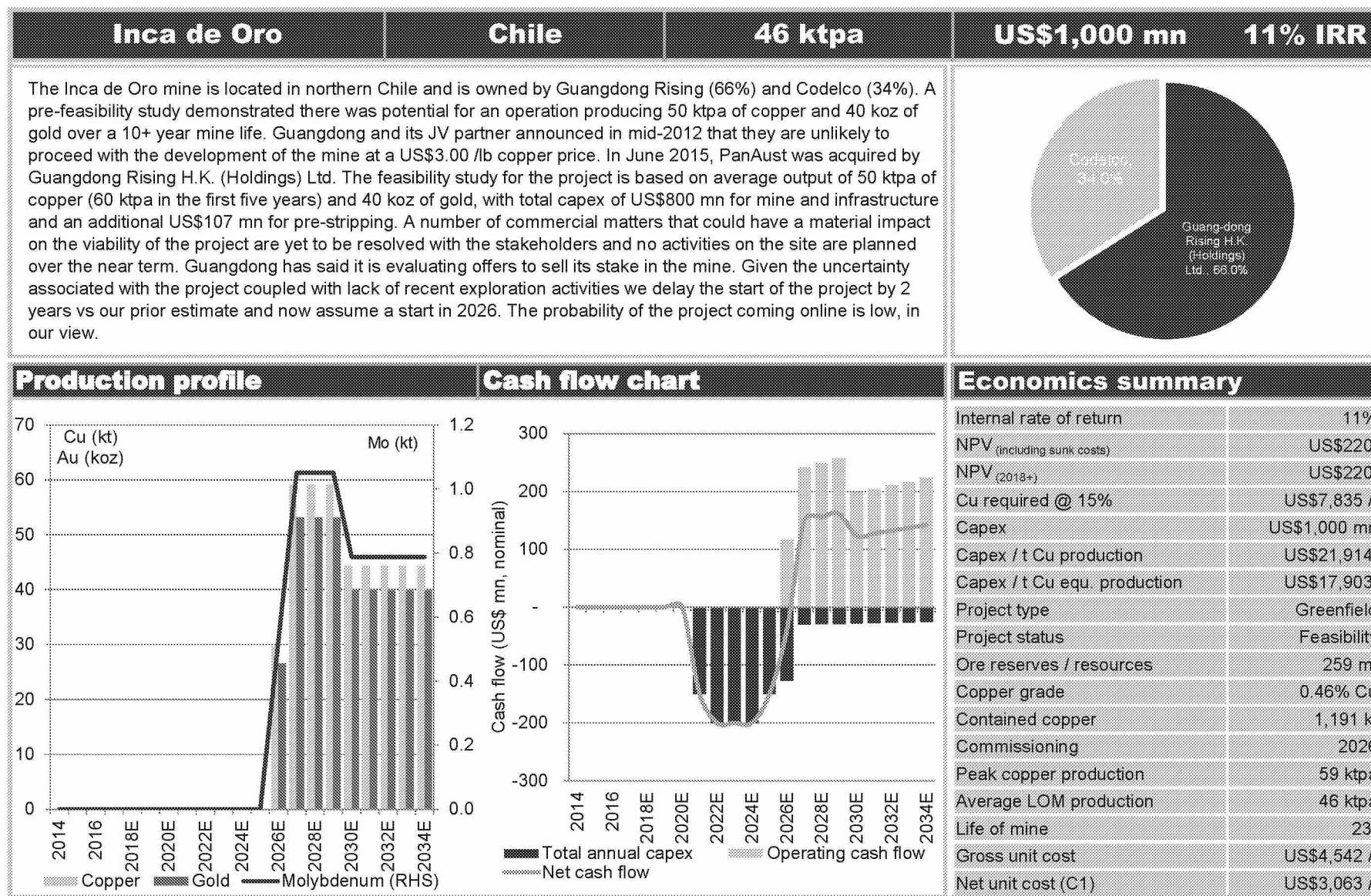
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 117: Harper Creek



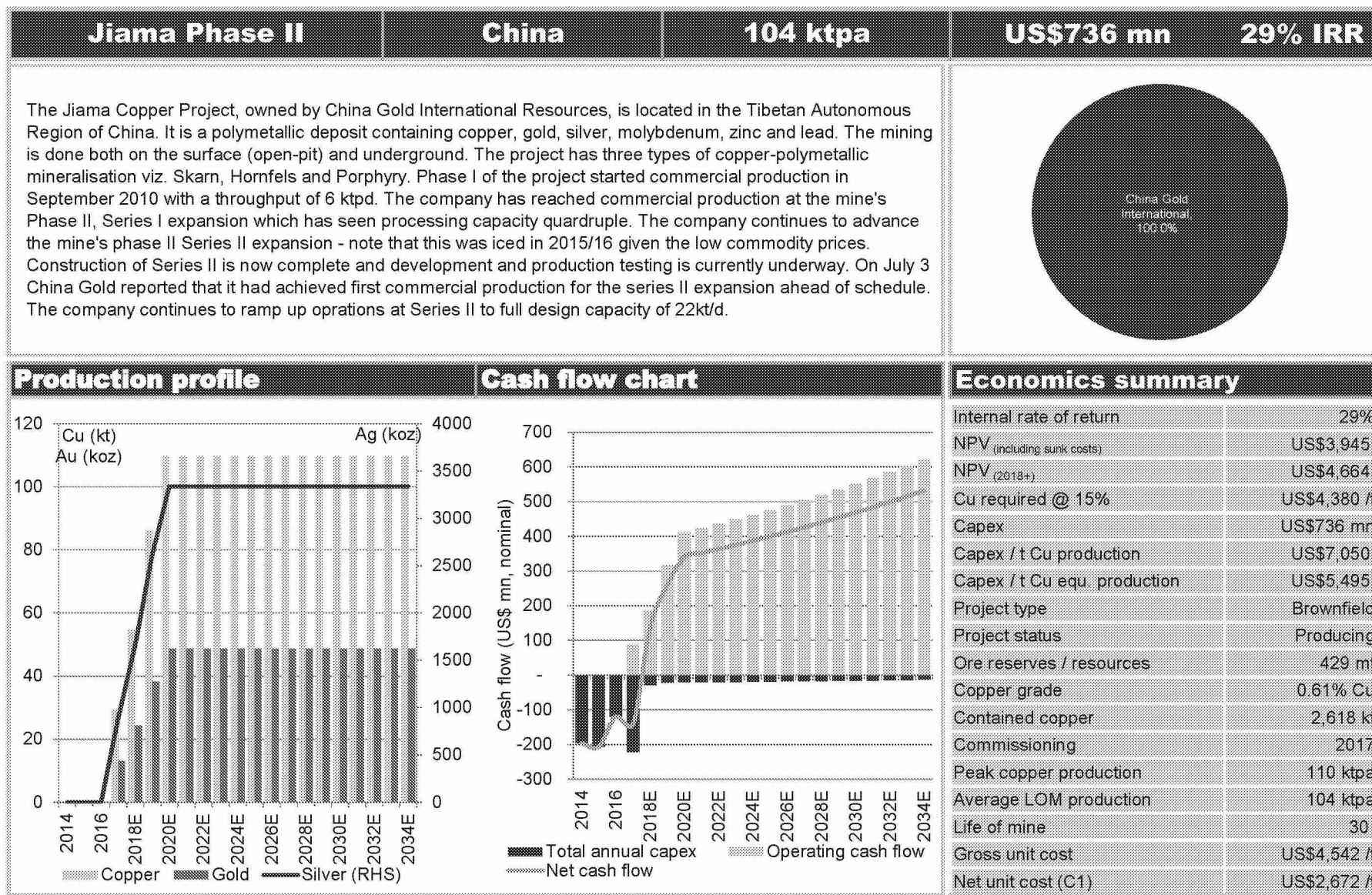
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 118: Inca de Oro



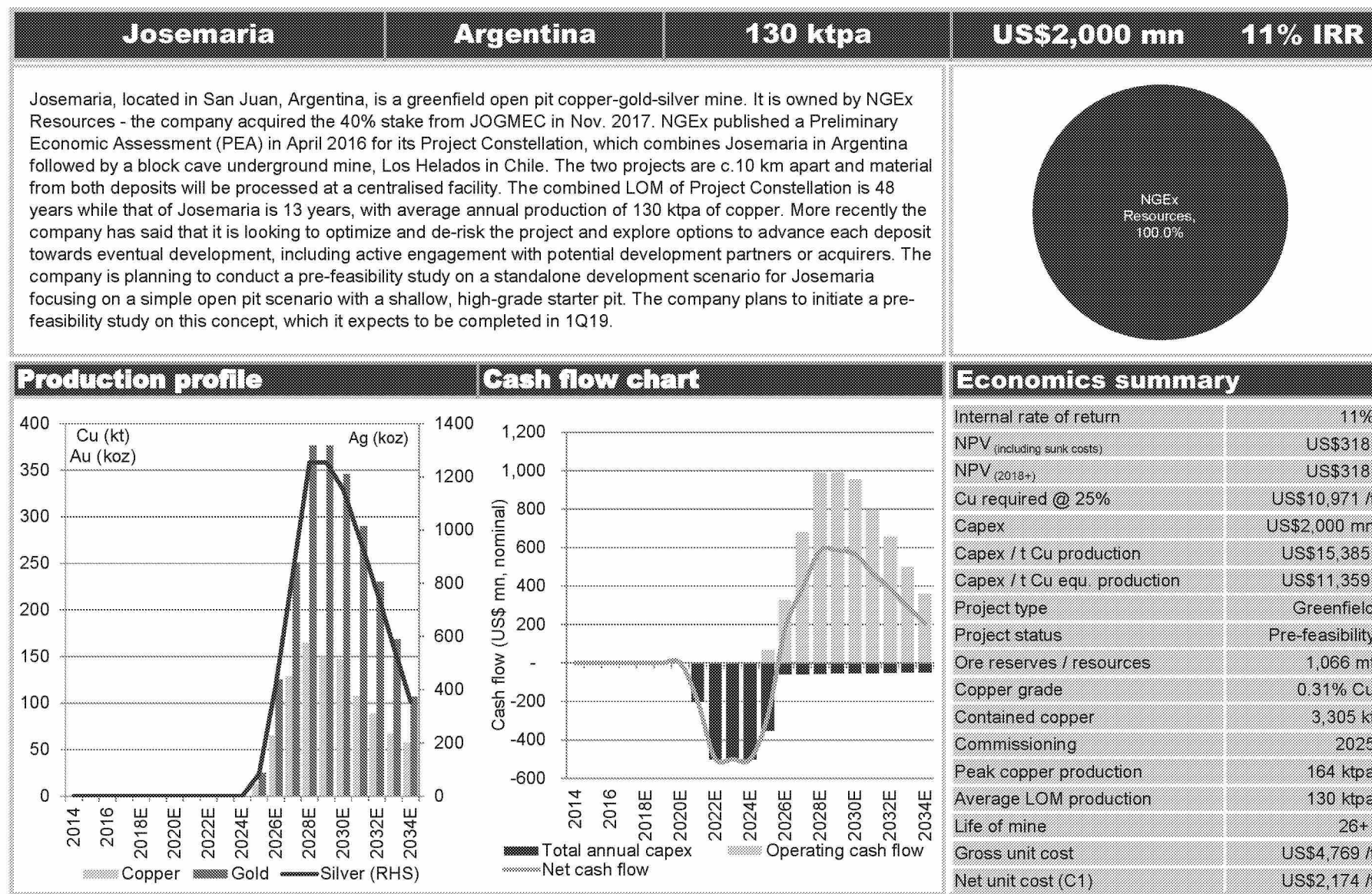
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 119: Jiama Phase II



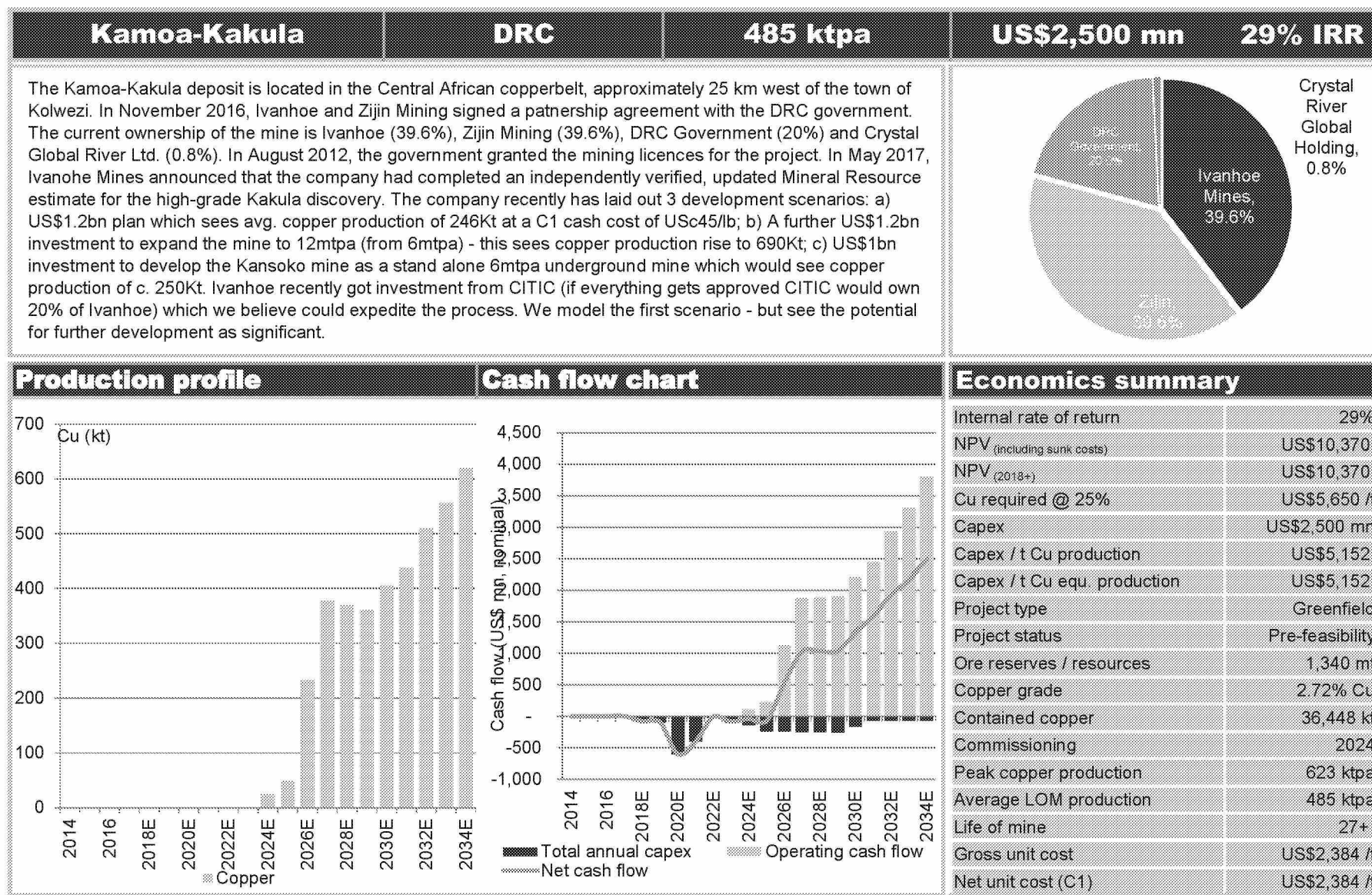
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 120: Josemaria



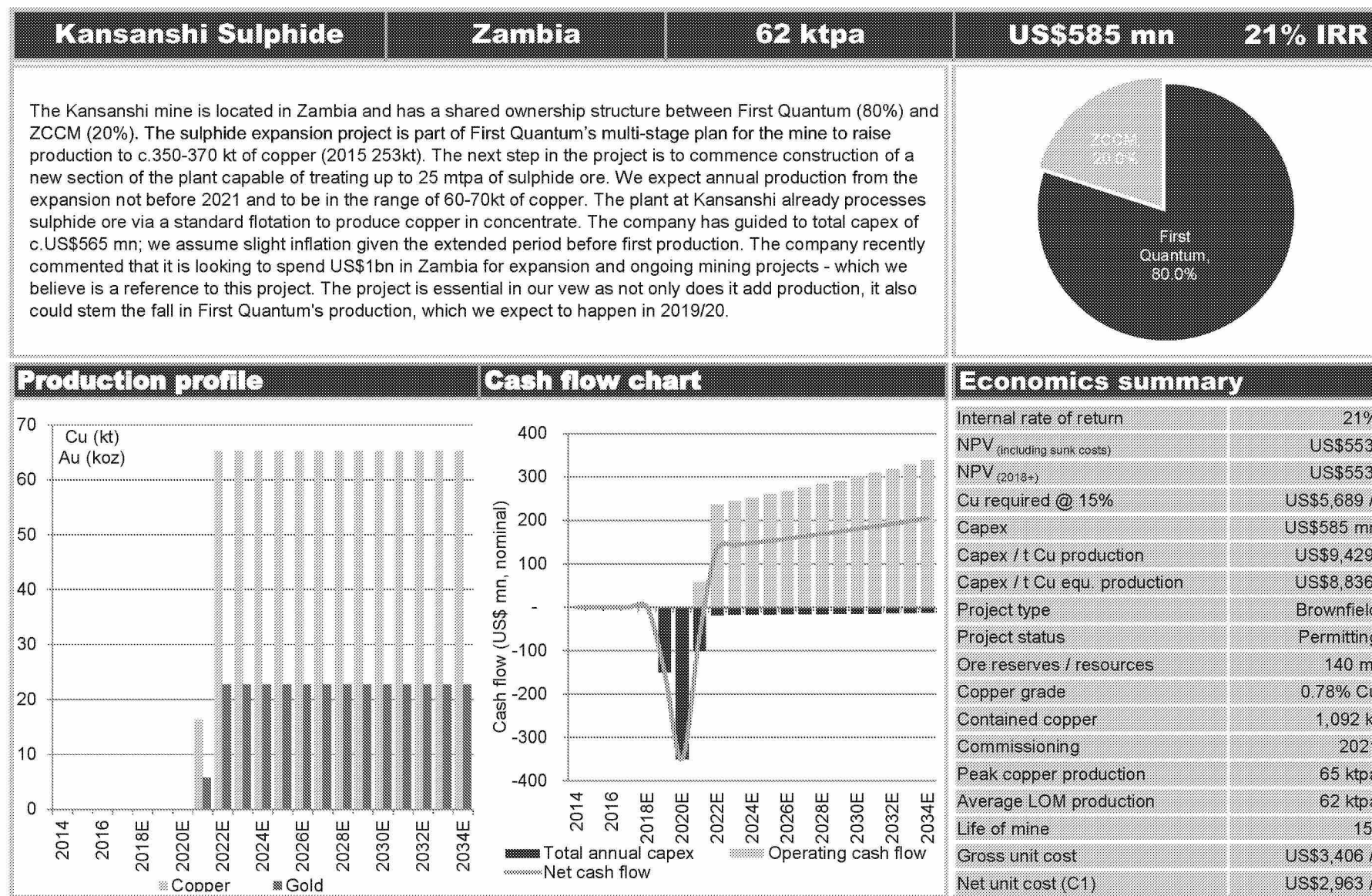
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 121: Kamoa-Kakula



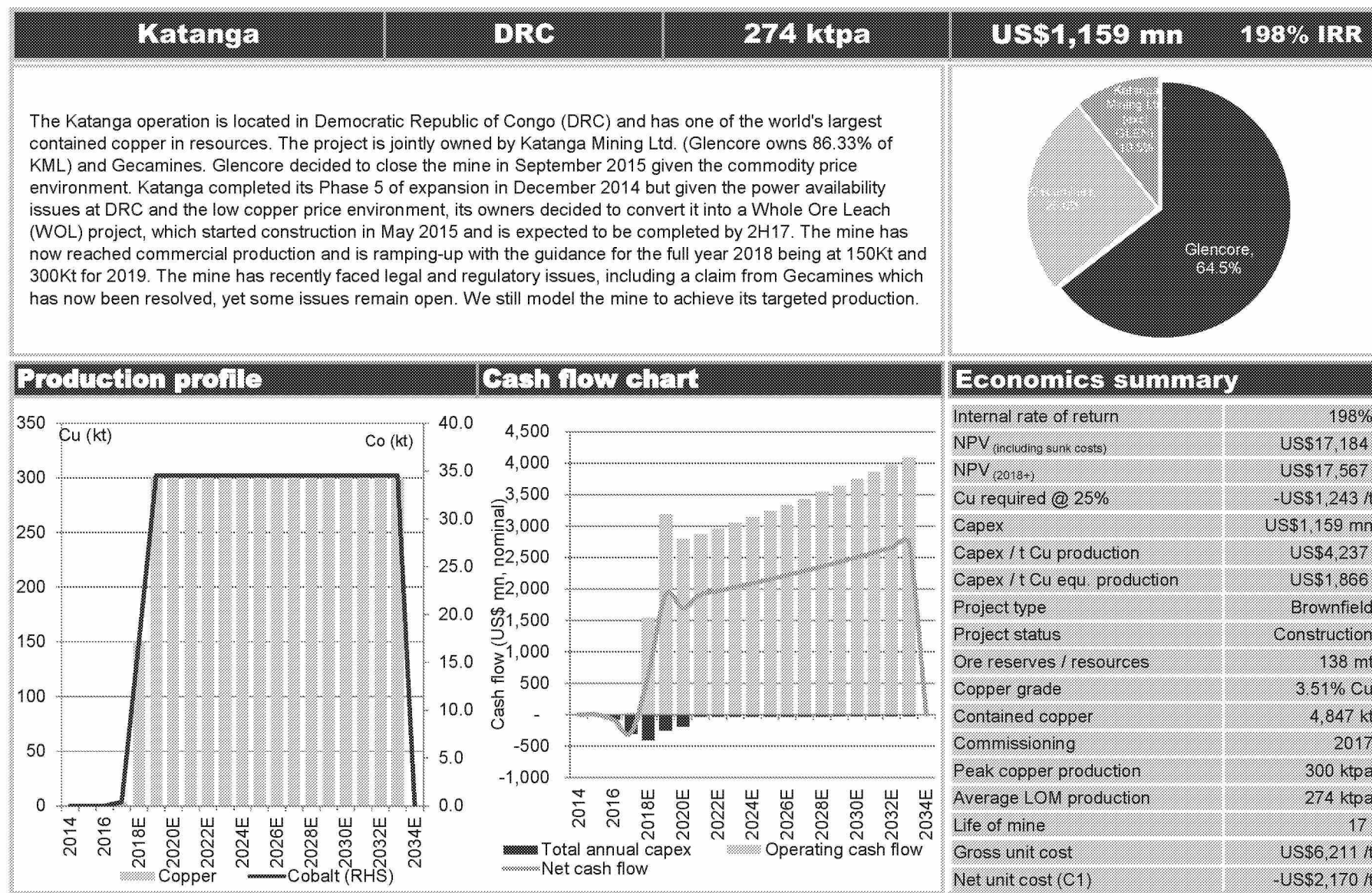
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 122: Kansanshi Sulphide



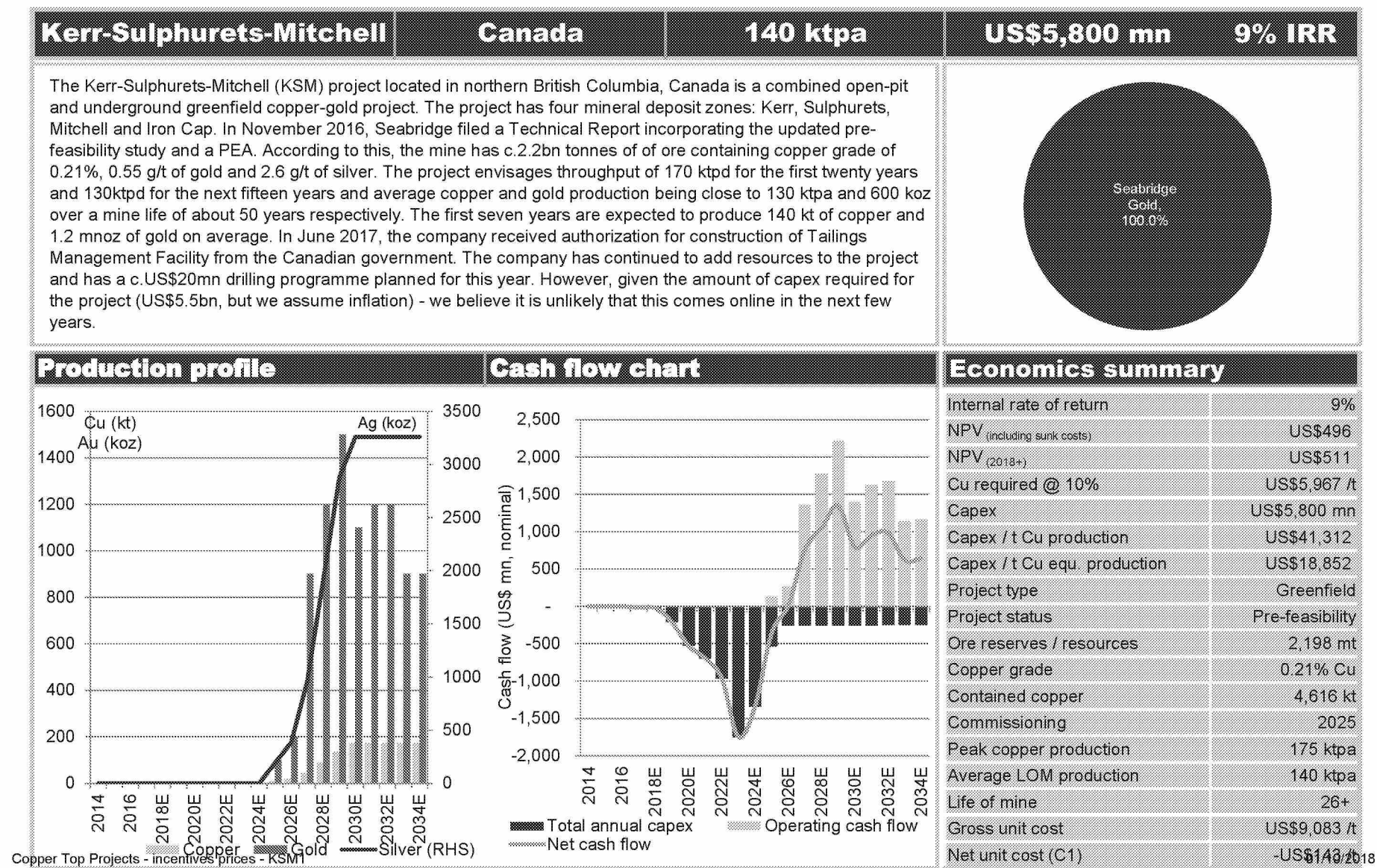
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 123: Katanga



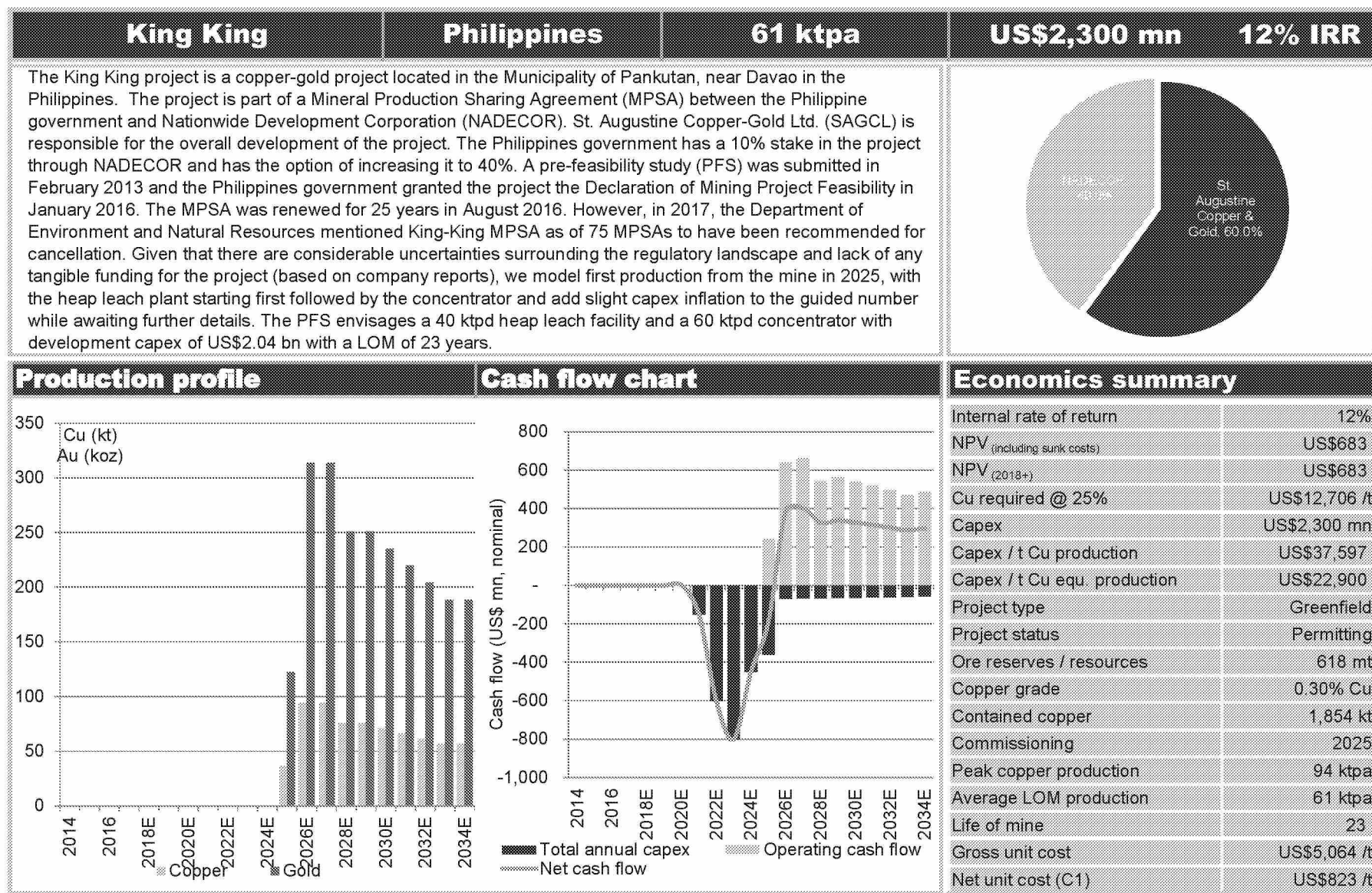
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 124: Kerr-Sulphurets-Mitchell



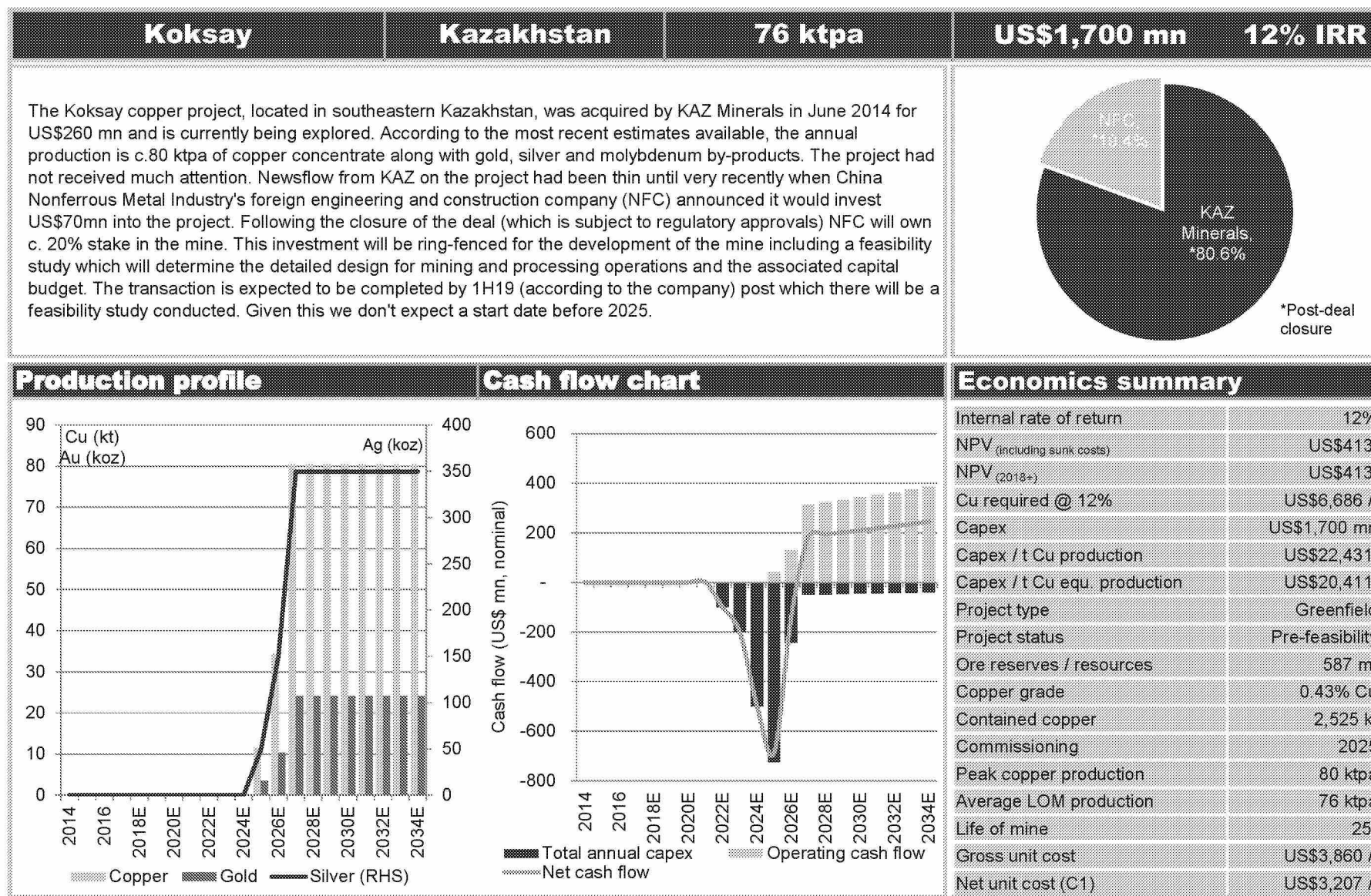
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 125: King King



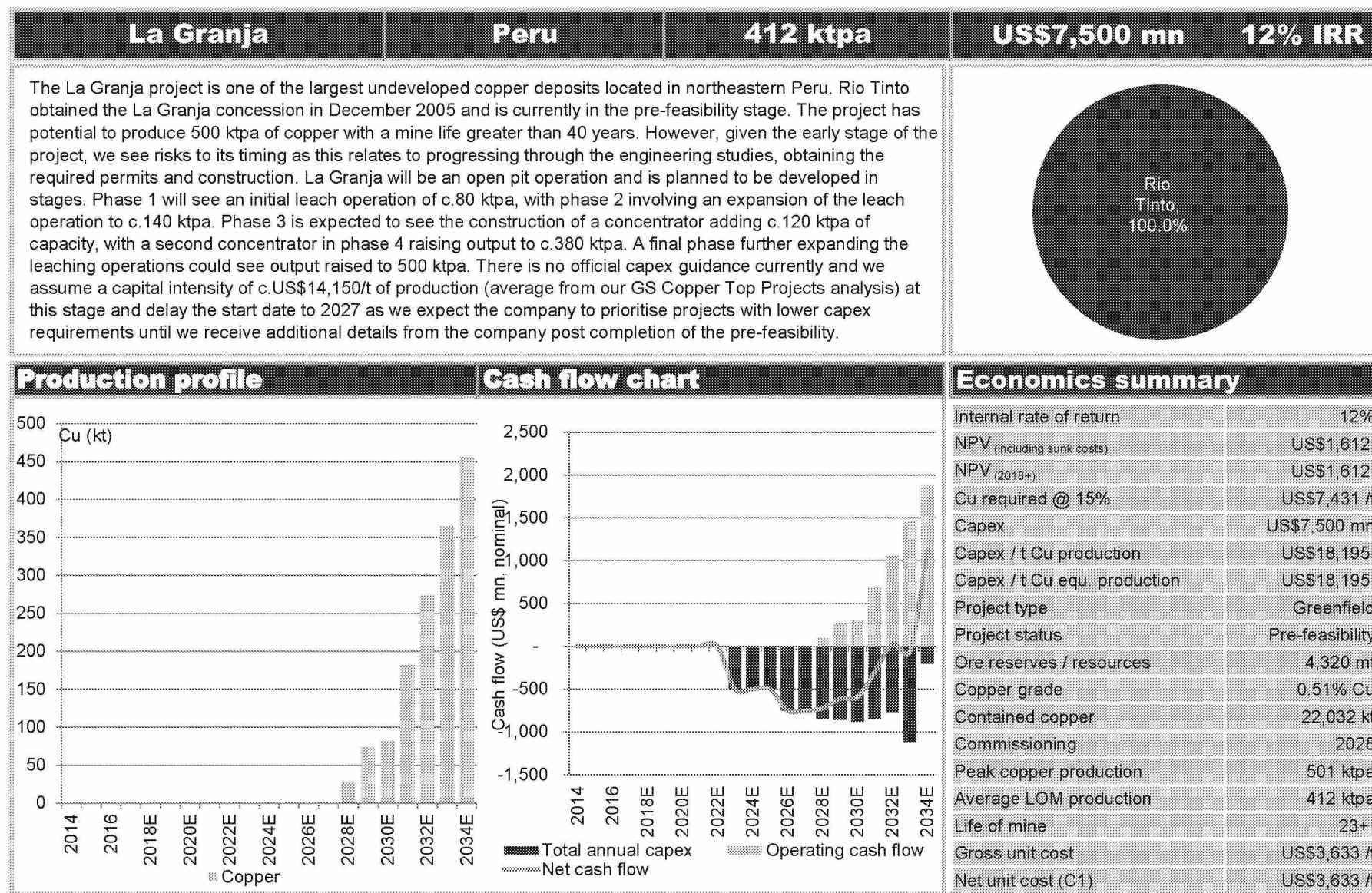
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 126: Koksay



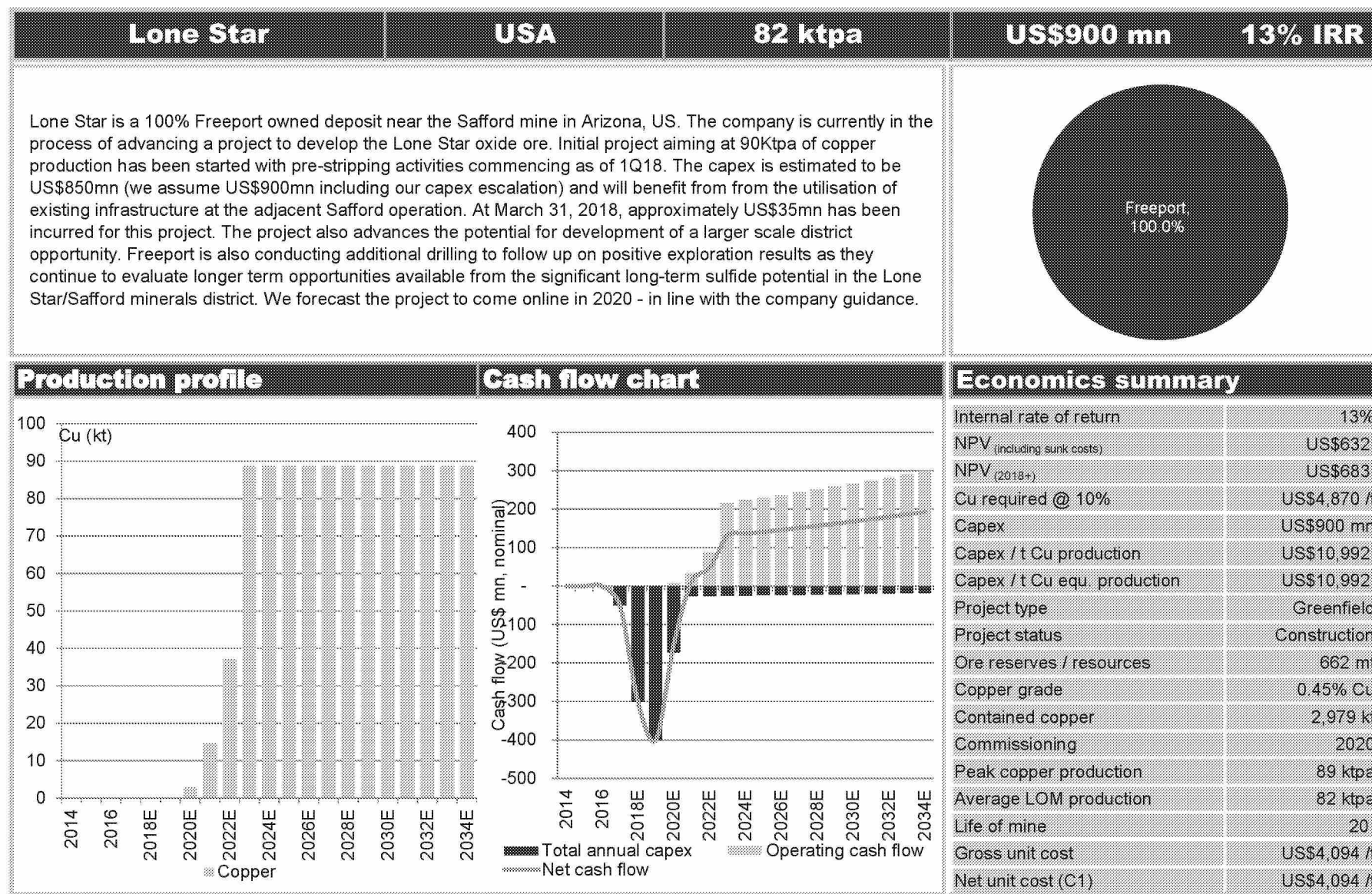
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 127: La Granja



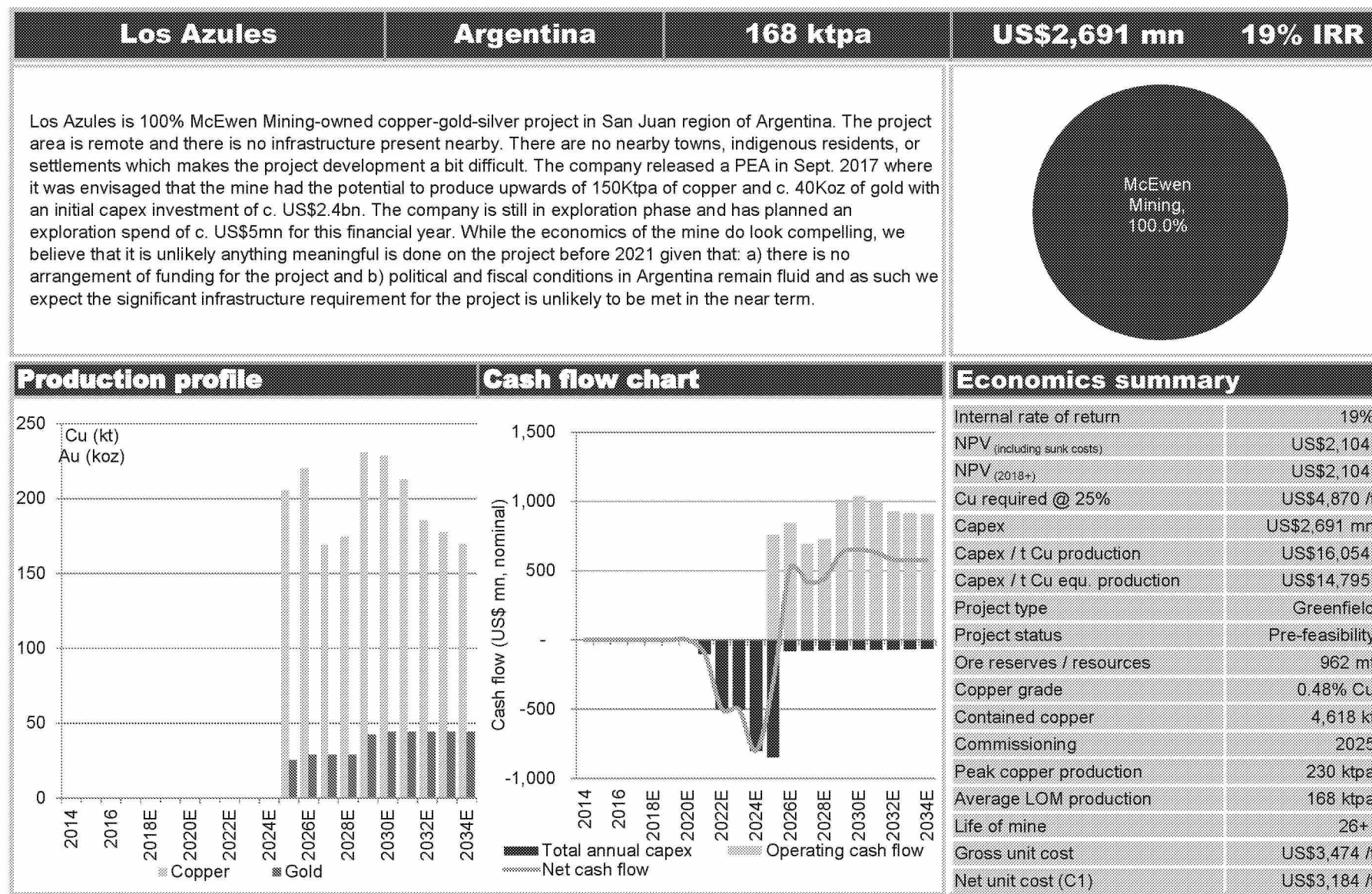
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 128: Lone Star



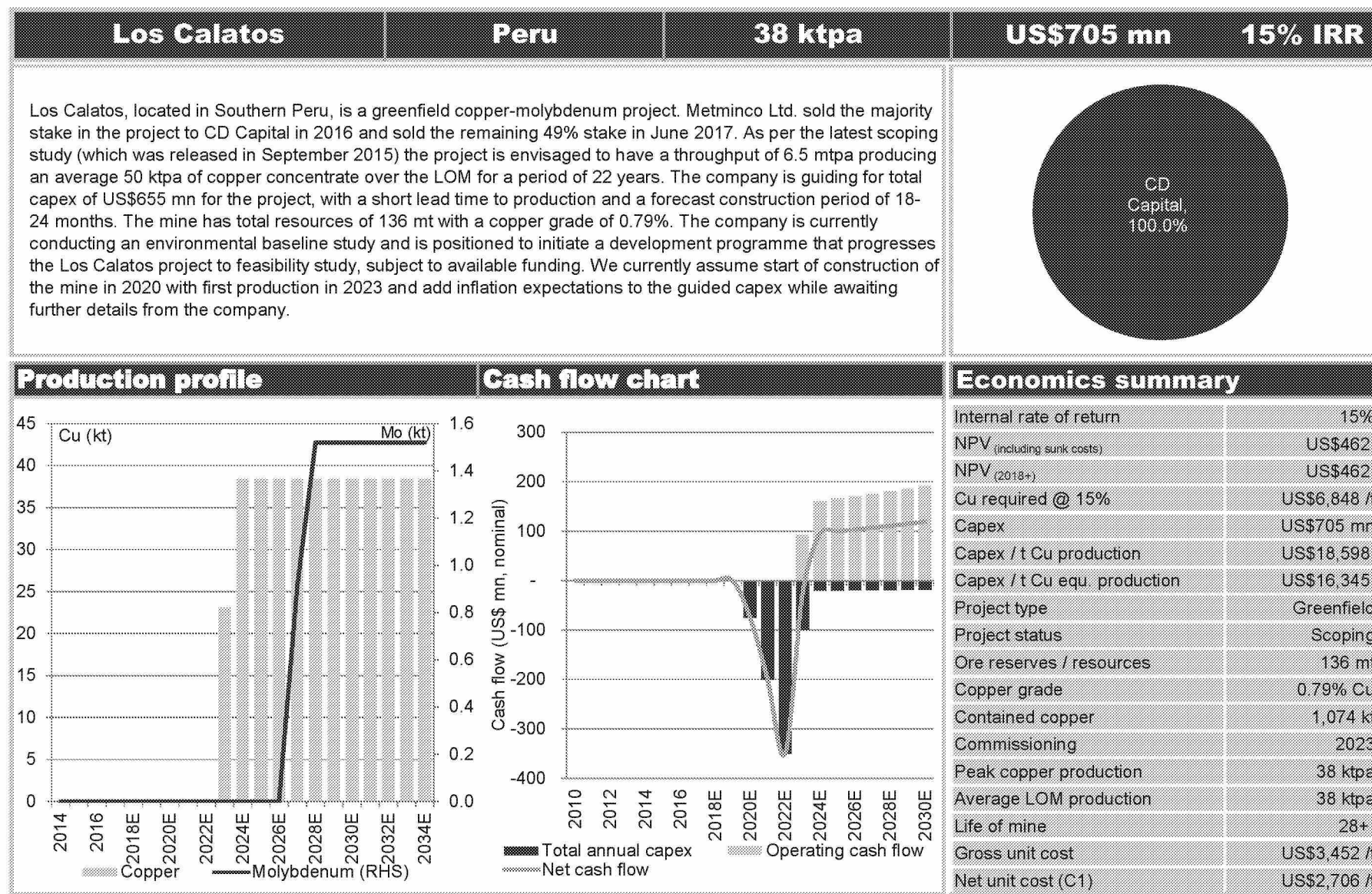
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 129: Los Azules



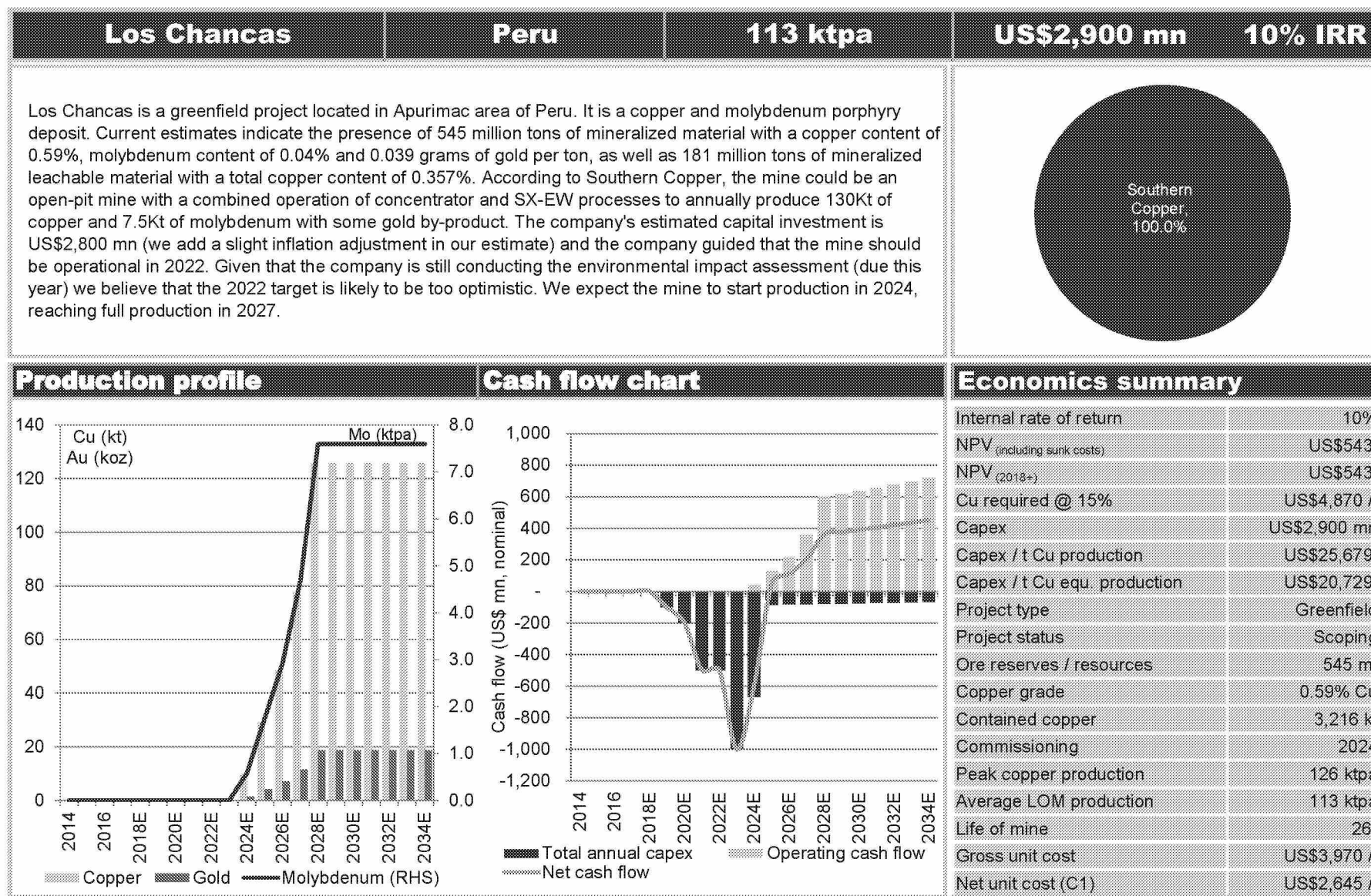
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 130: Los Calatos



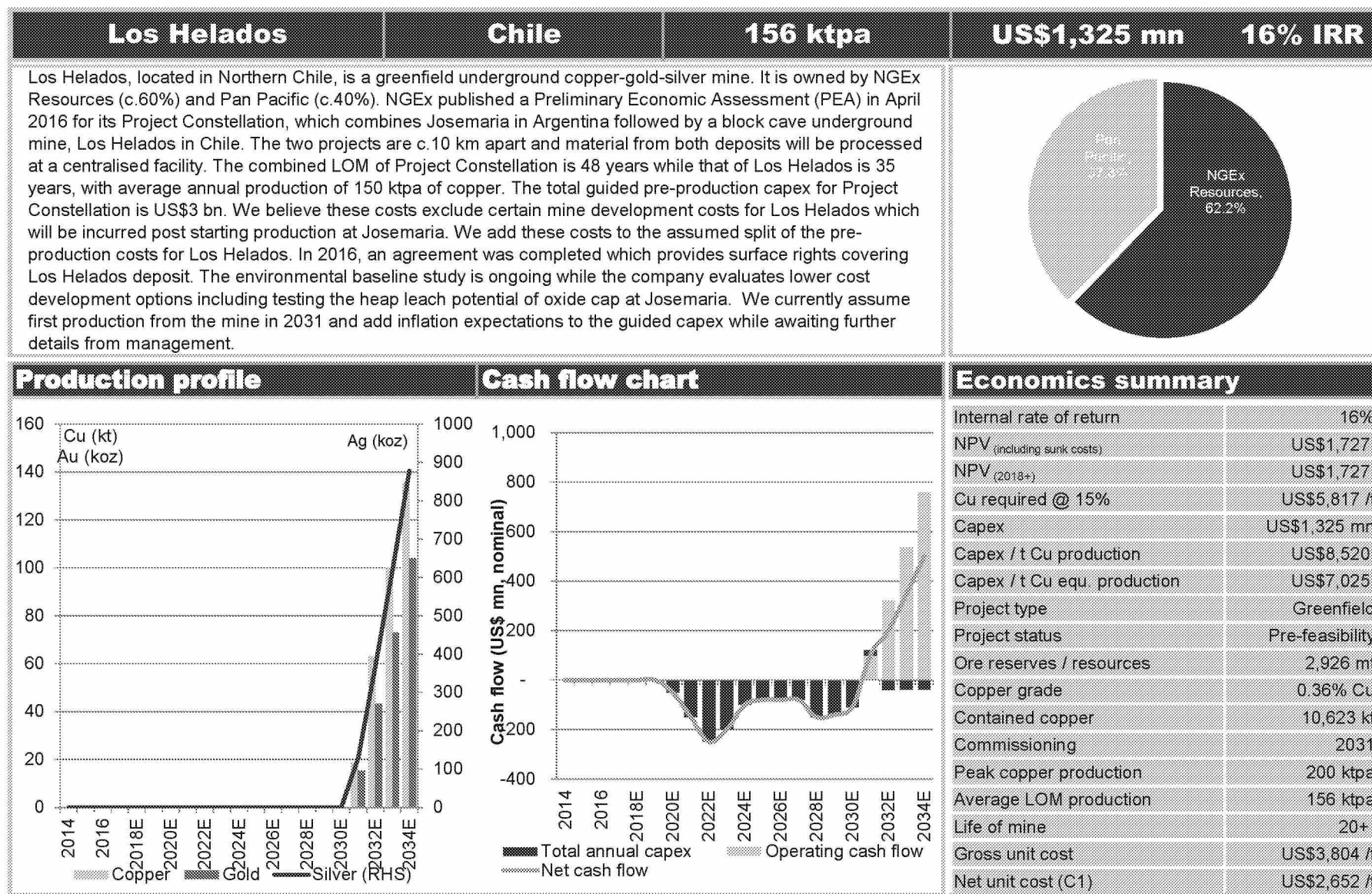
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 131: Los Chancas



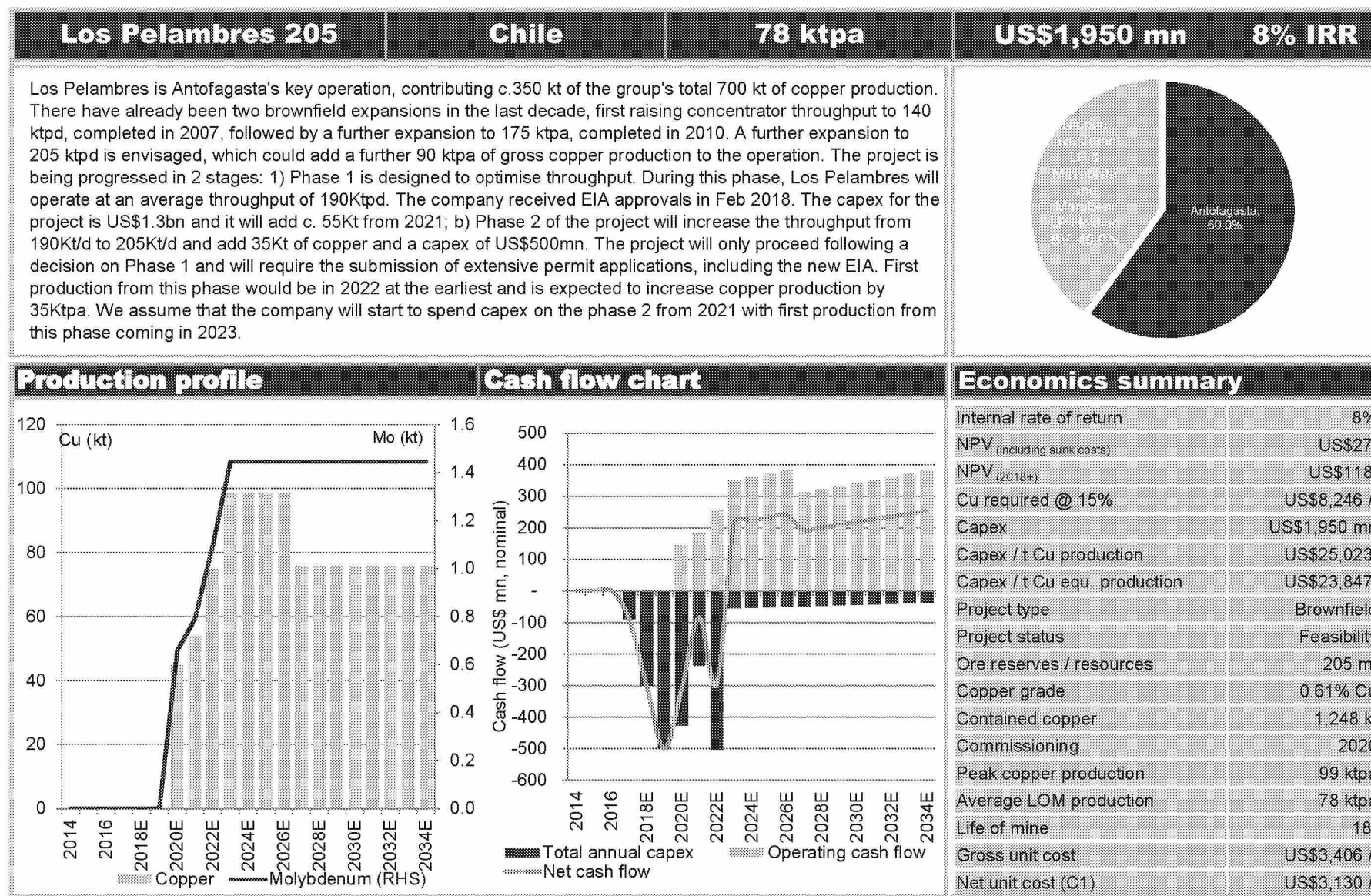
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 132: Los Helados



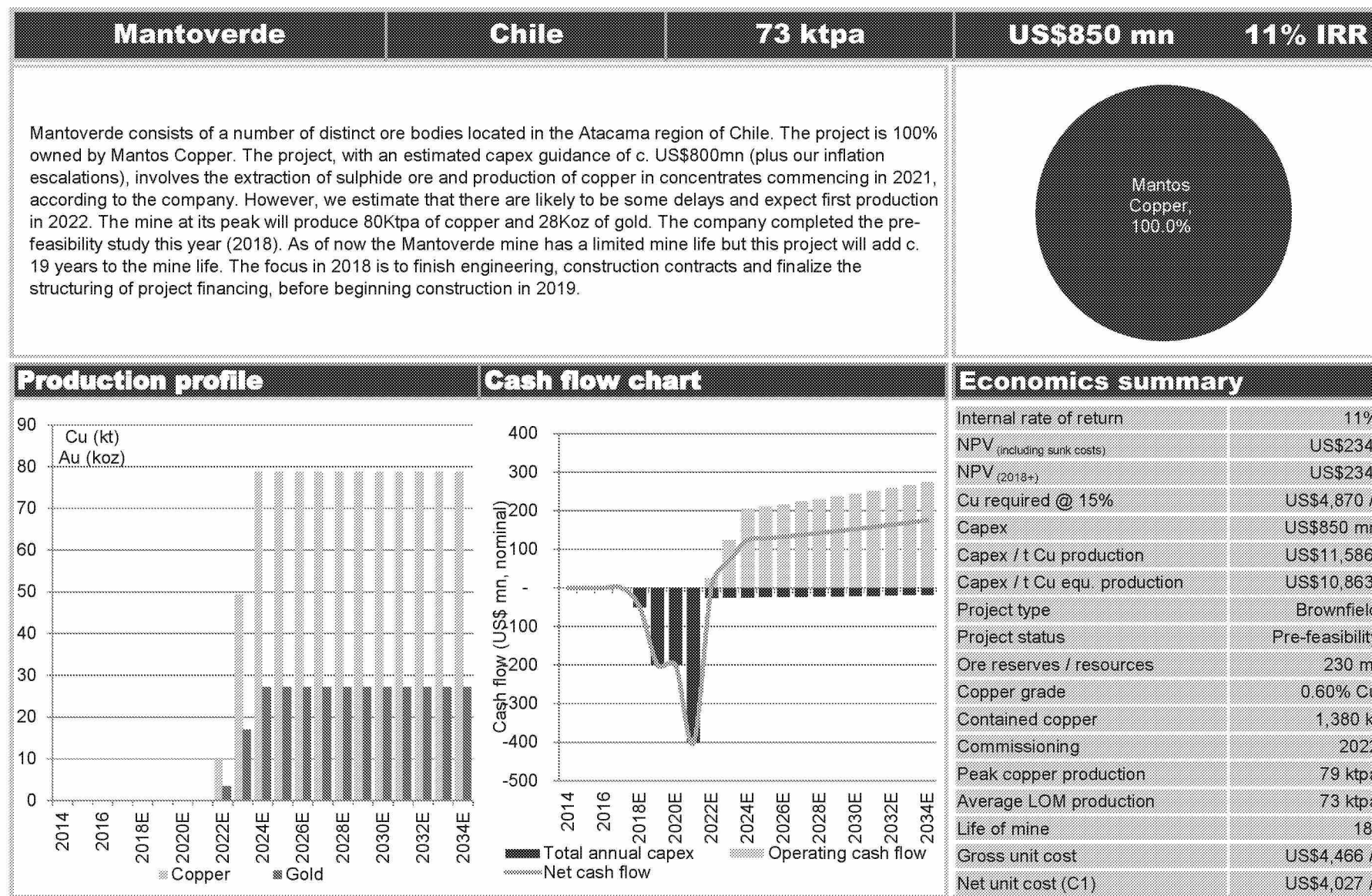
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 133: Los Pelambres 205



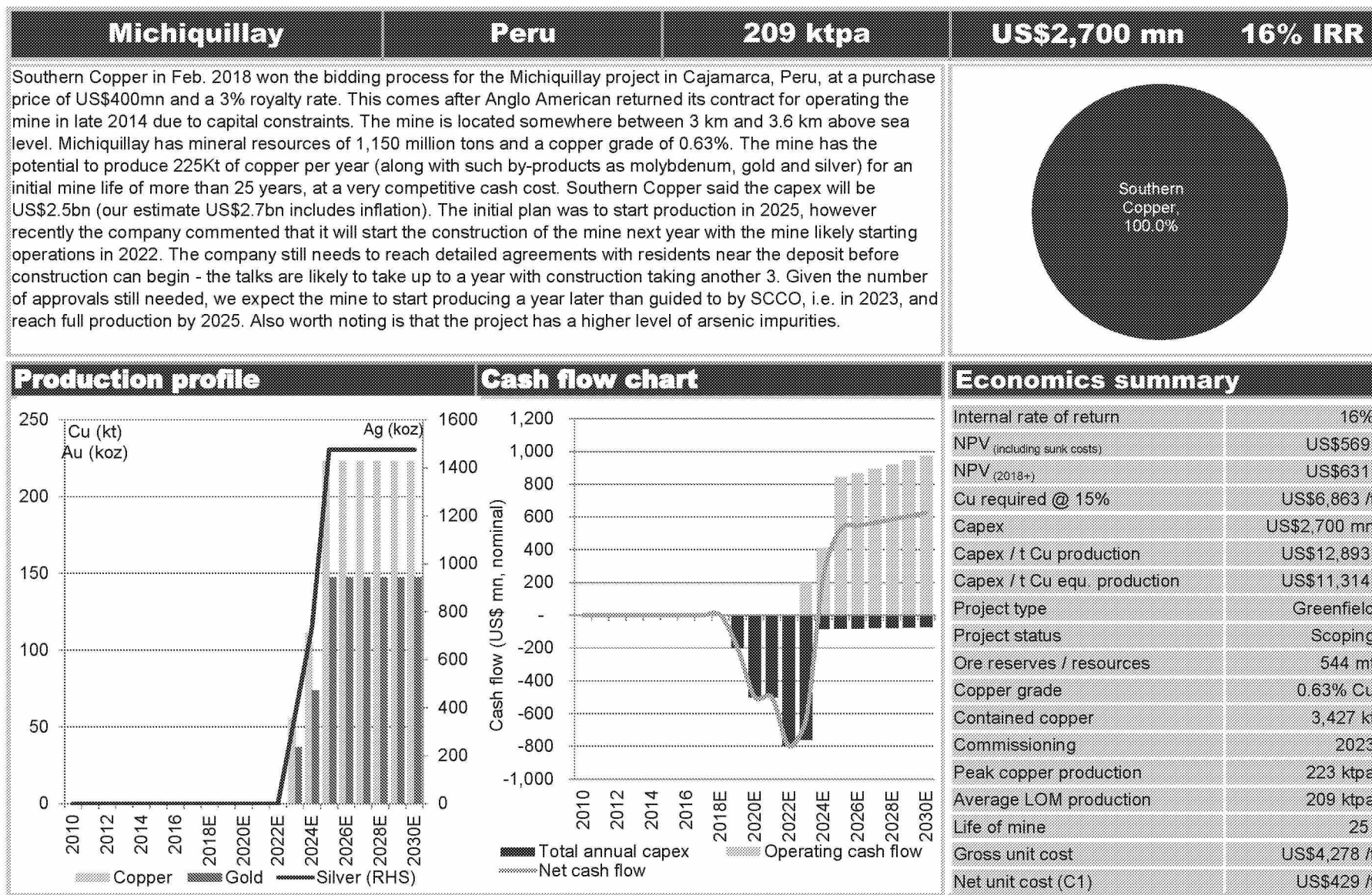
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 134: Mantoverde



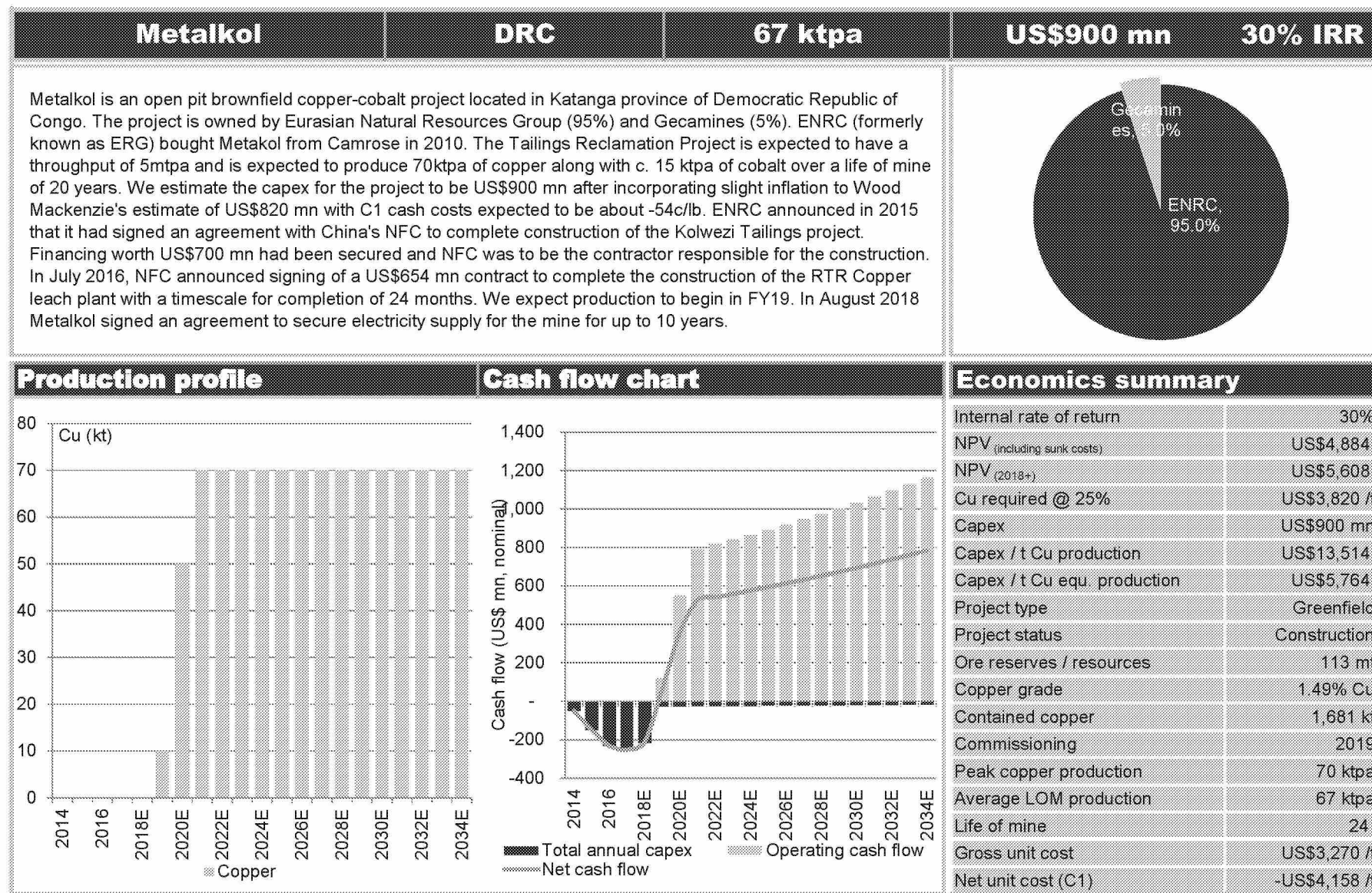
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 135: Michiquillay



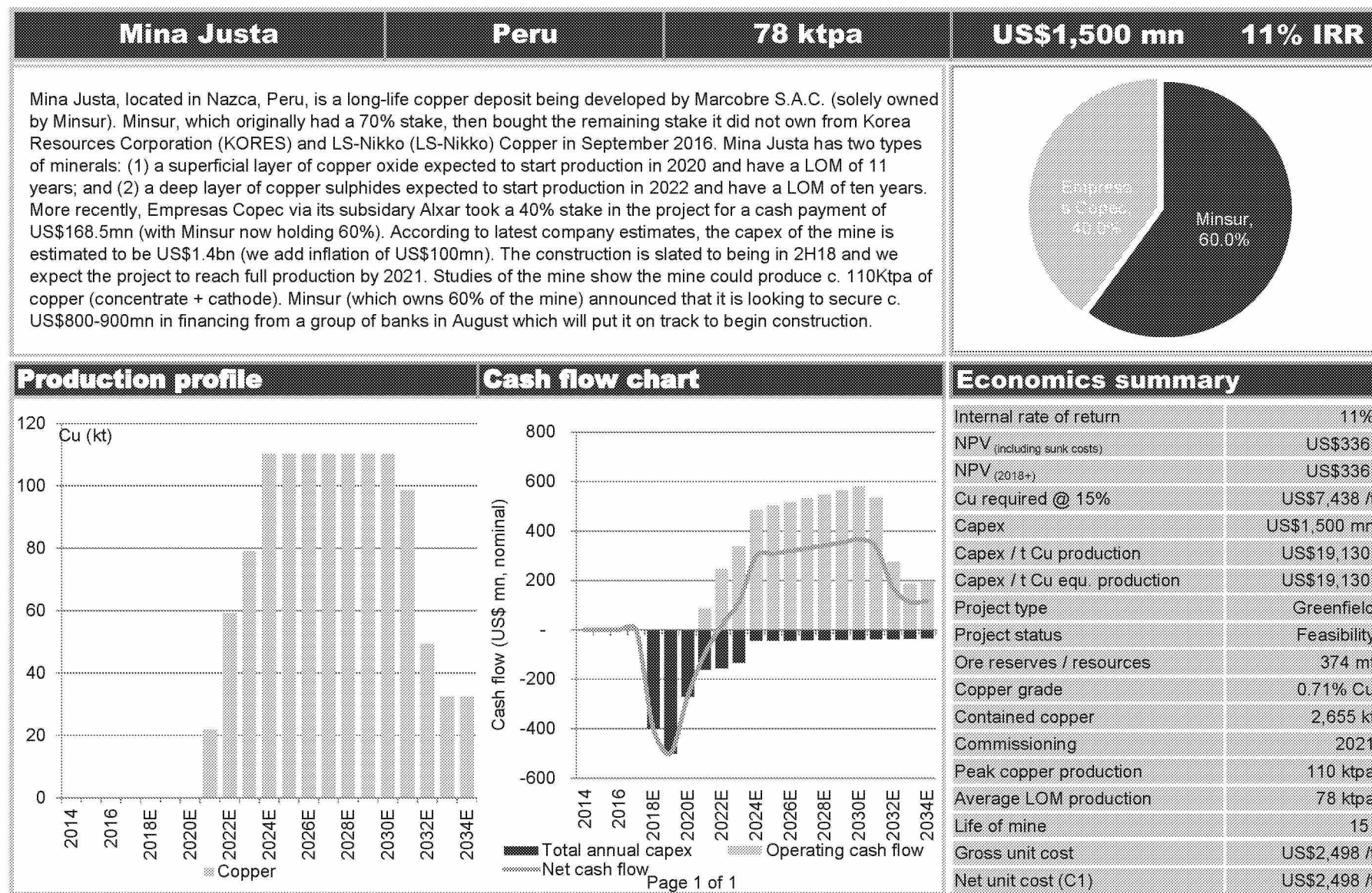
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 136: Metakol



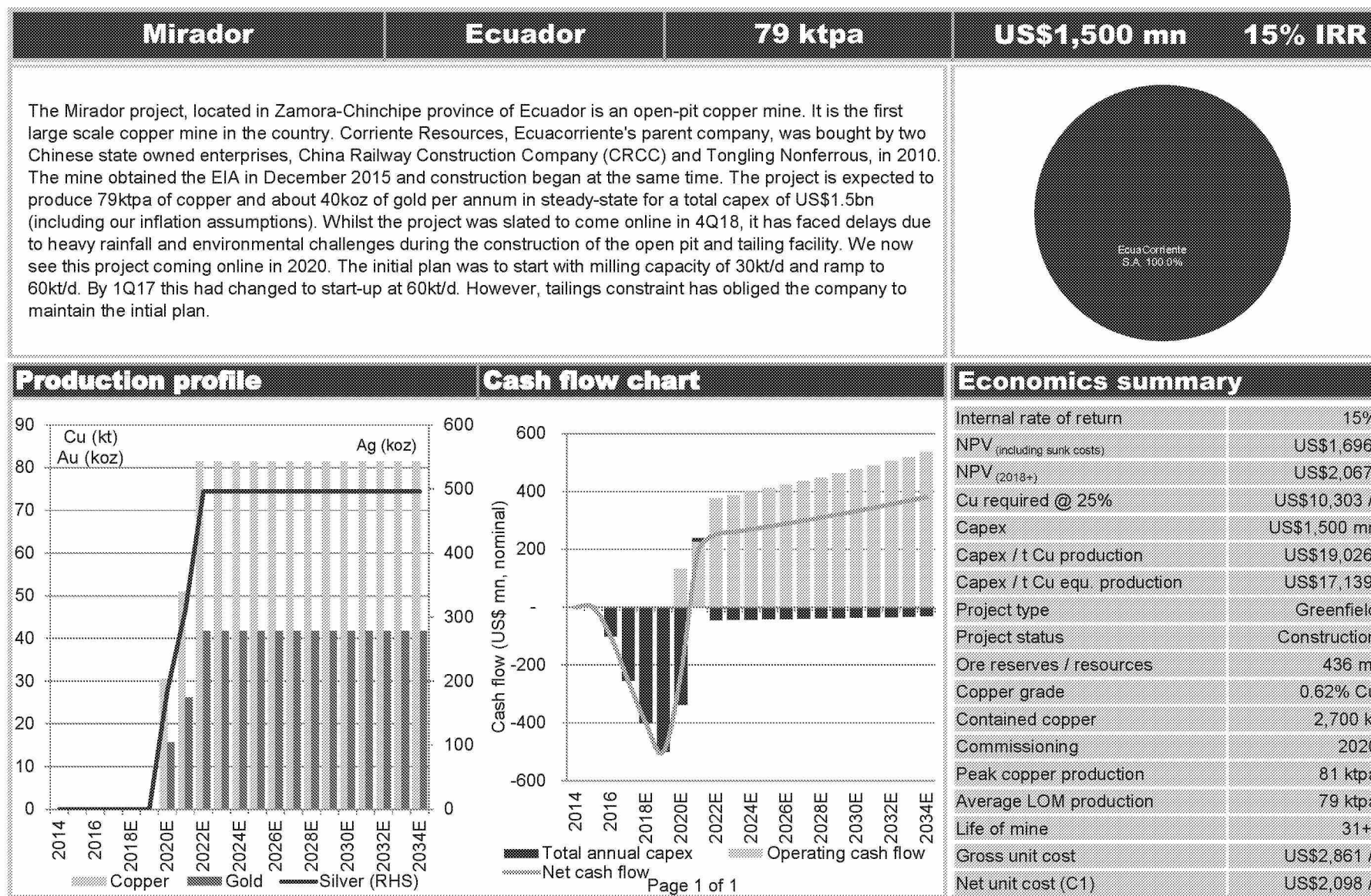
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 137: Mina Justa



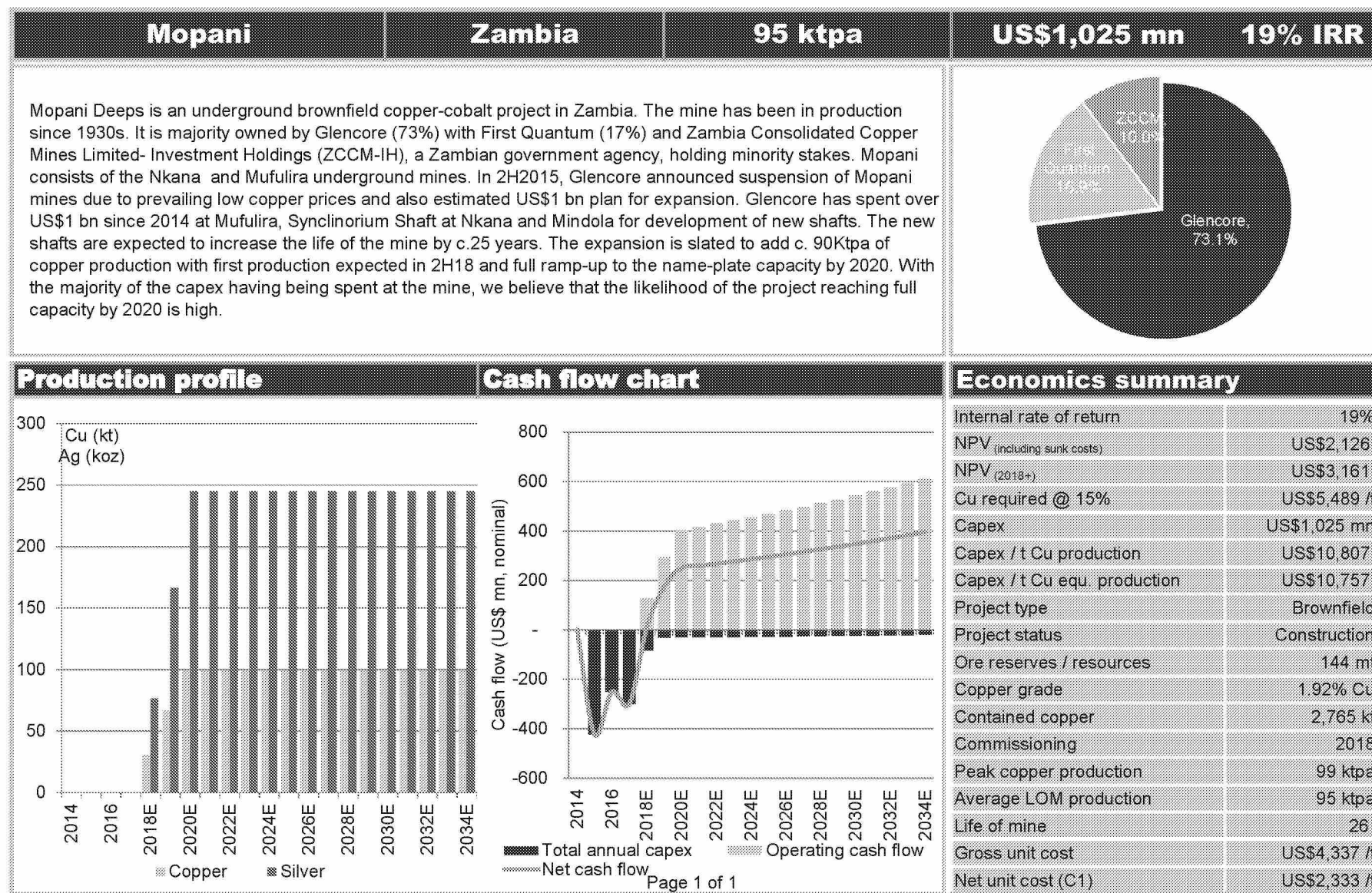
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 138: Mirador



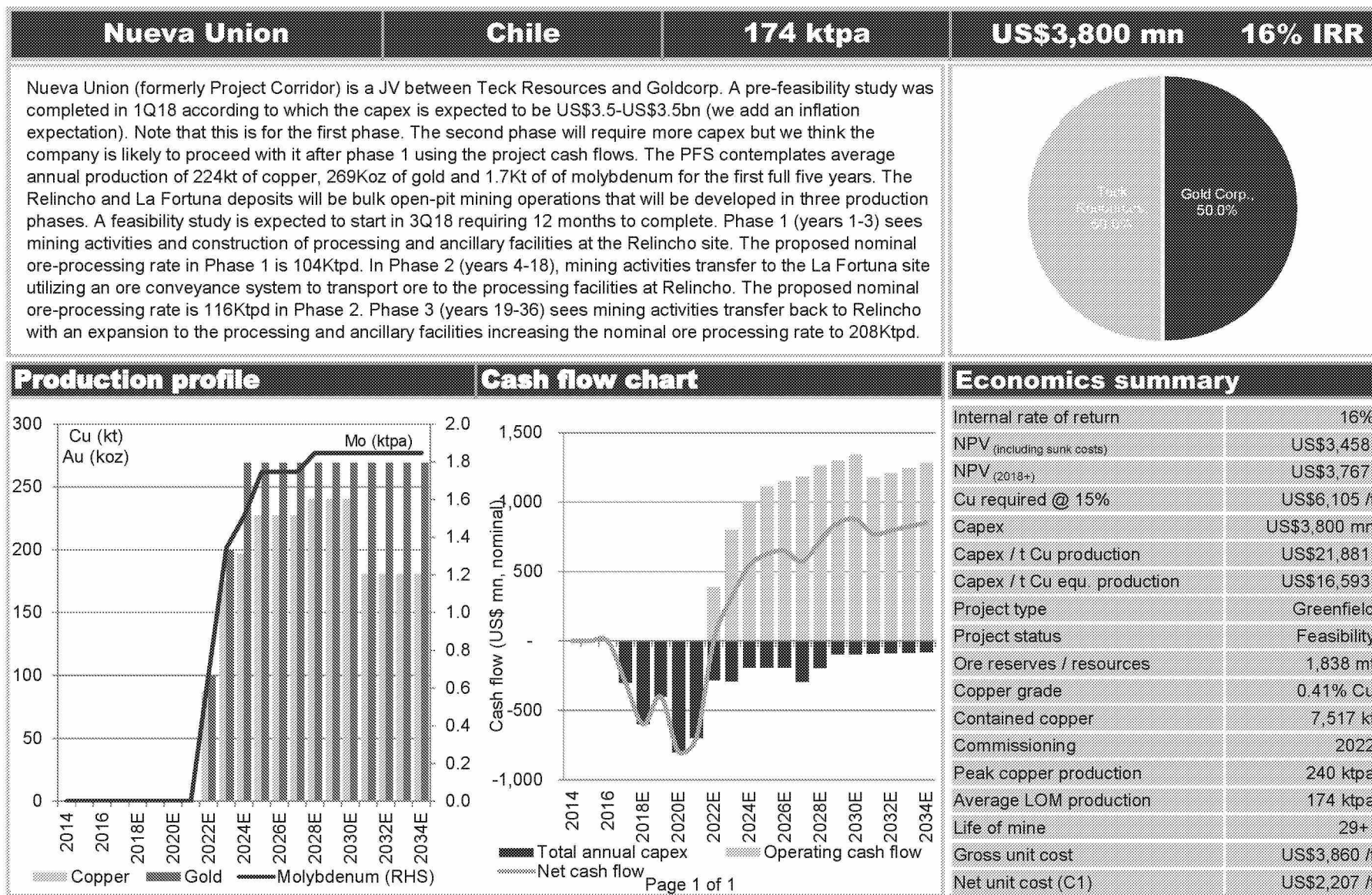
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 139: Mopani



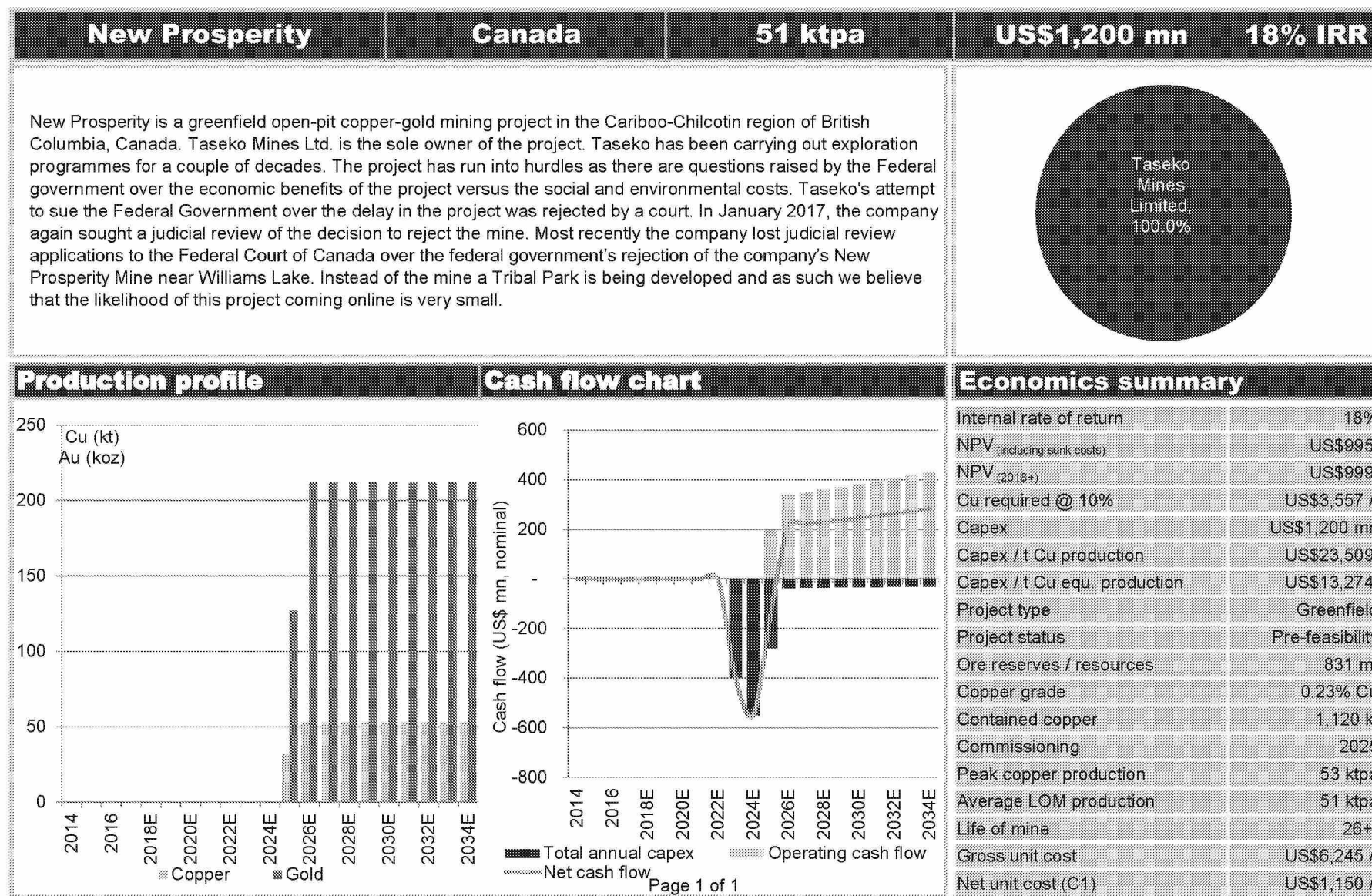
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 140: Nueva Union



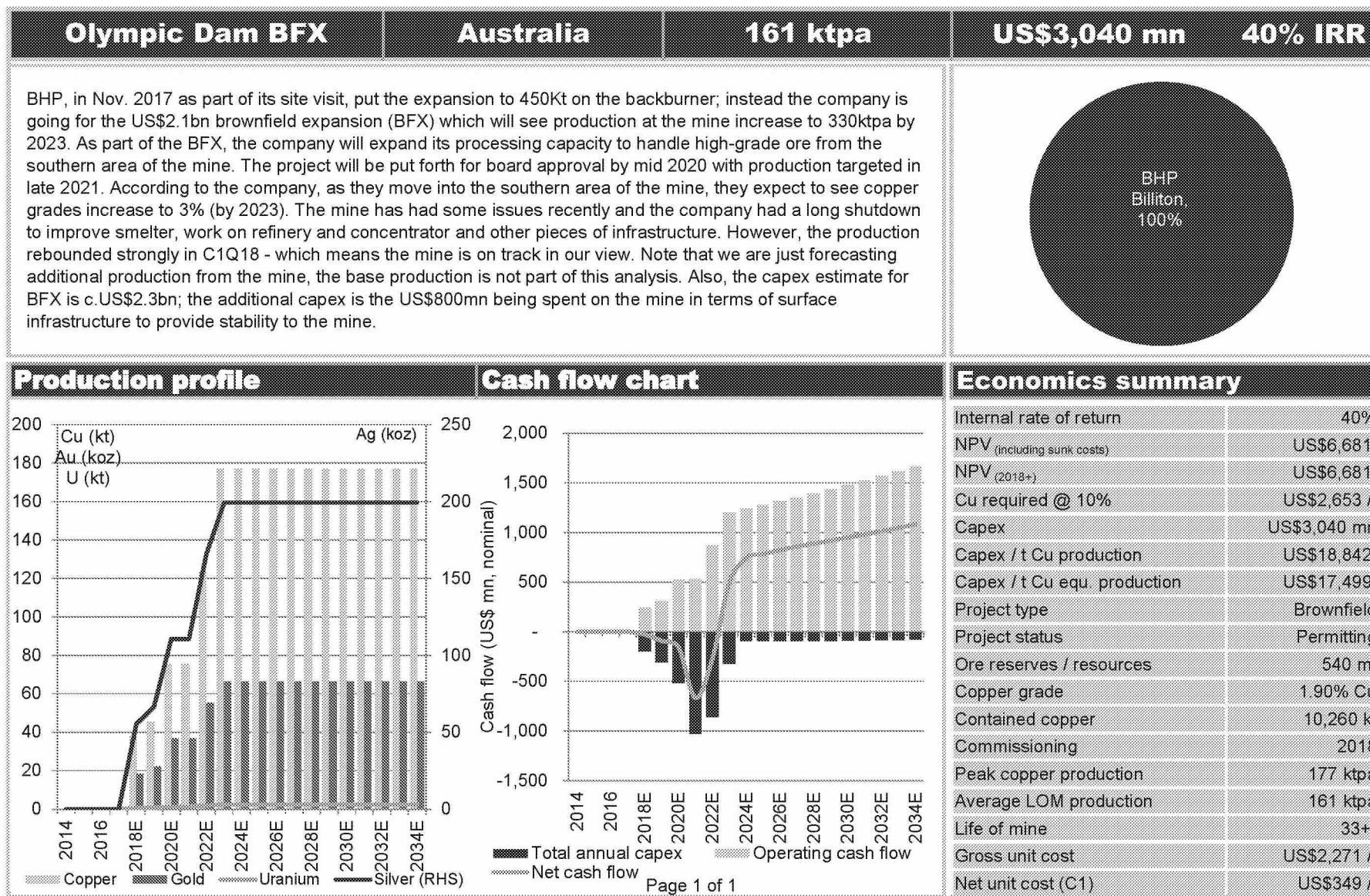
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 141: New Prosperity



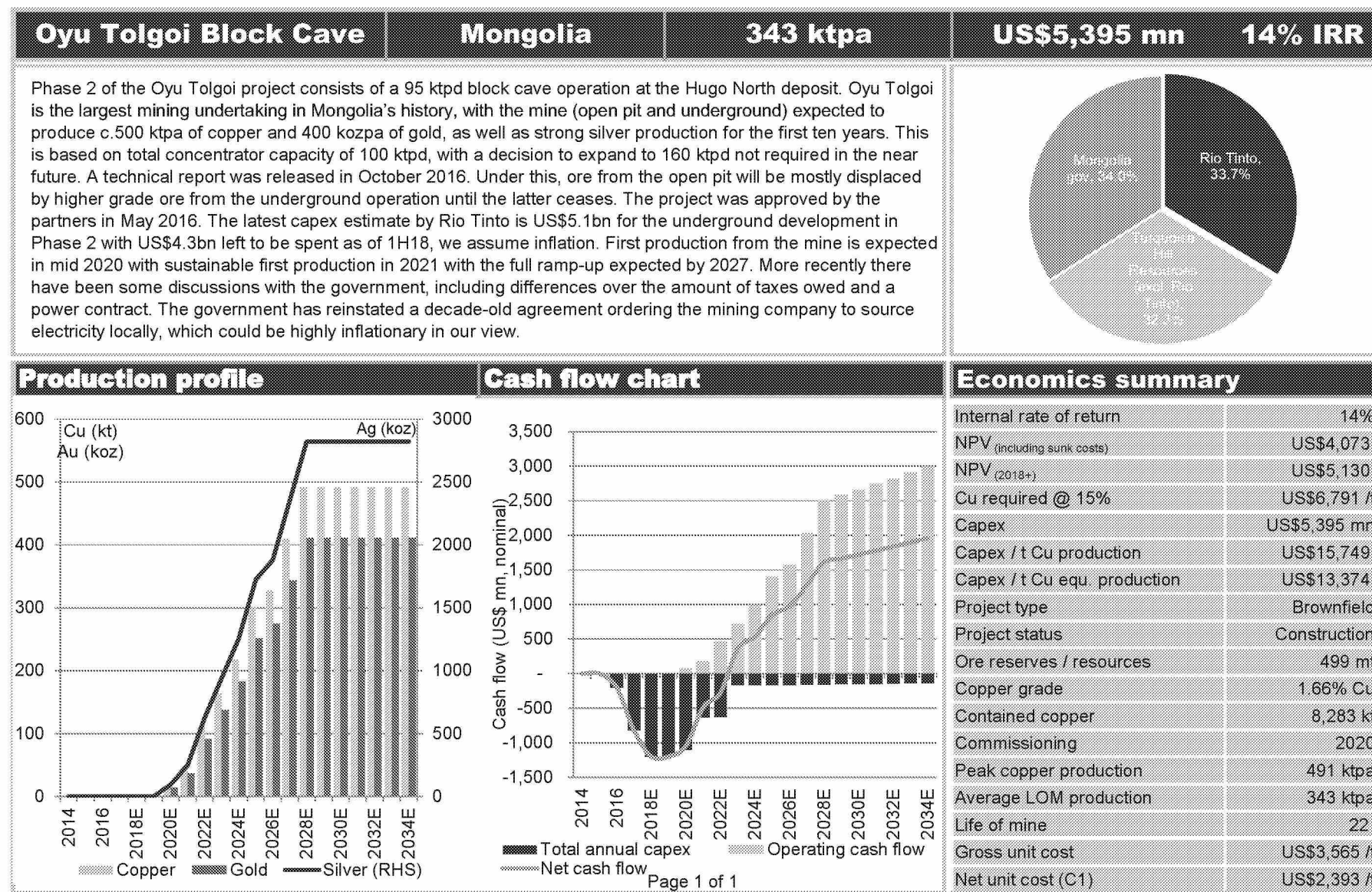
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 142: Olympic Dam BFX



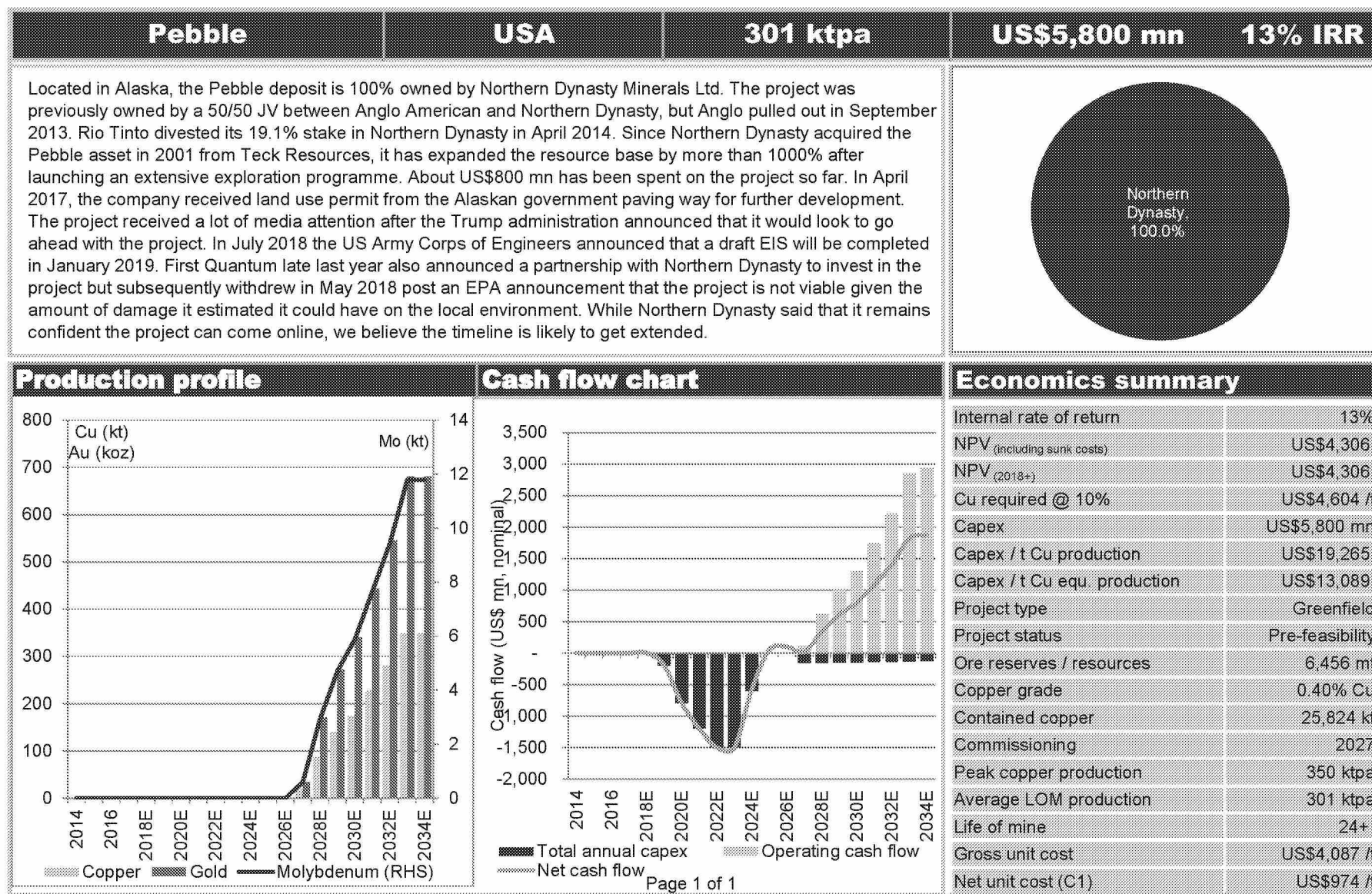
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 143: Oyu Tolgoi Block Cave



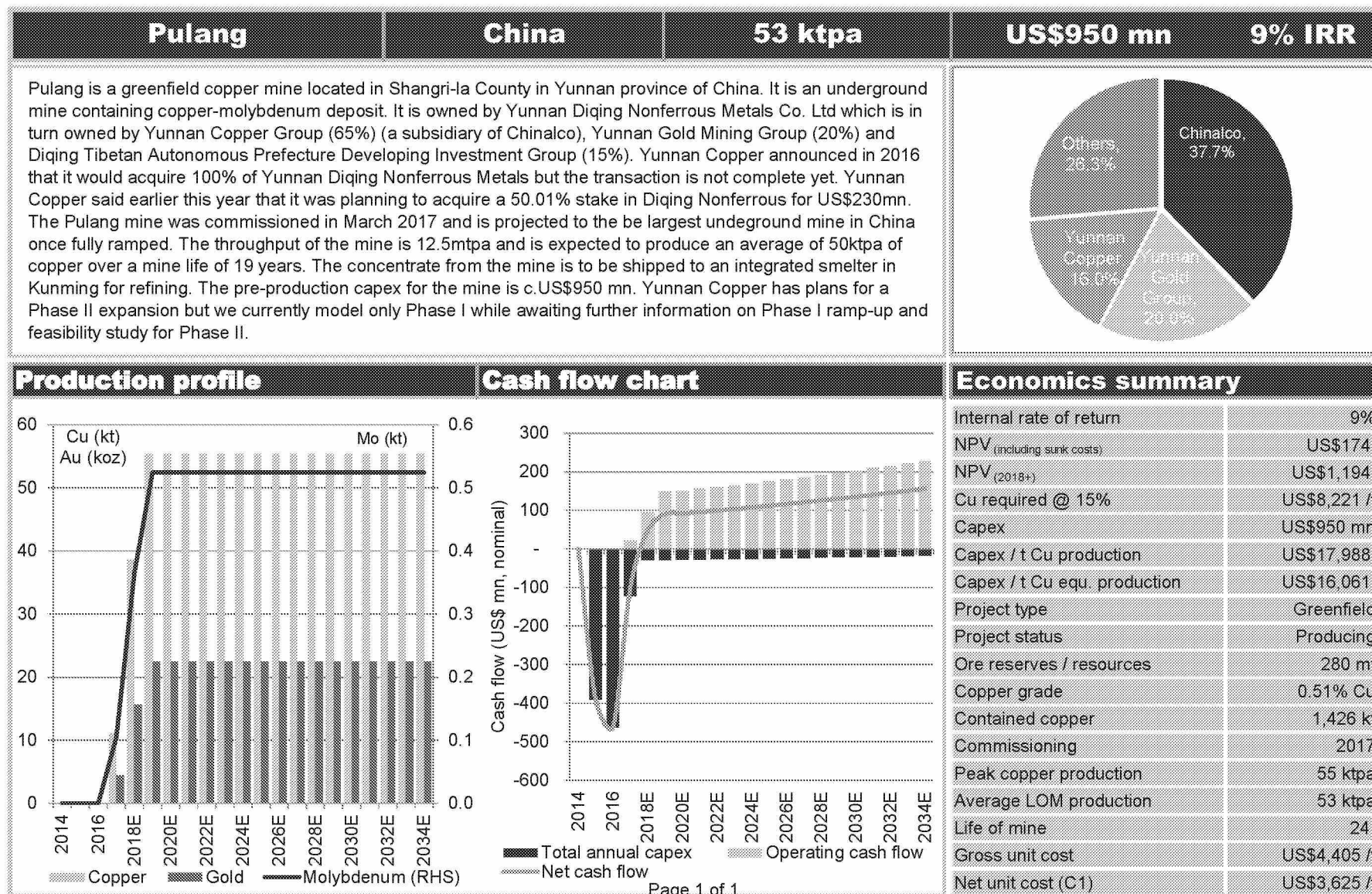
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 144: Pebble



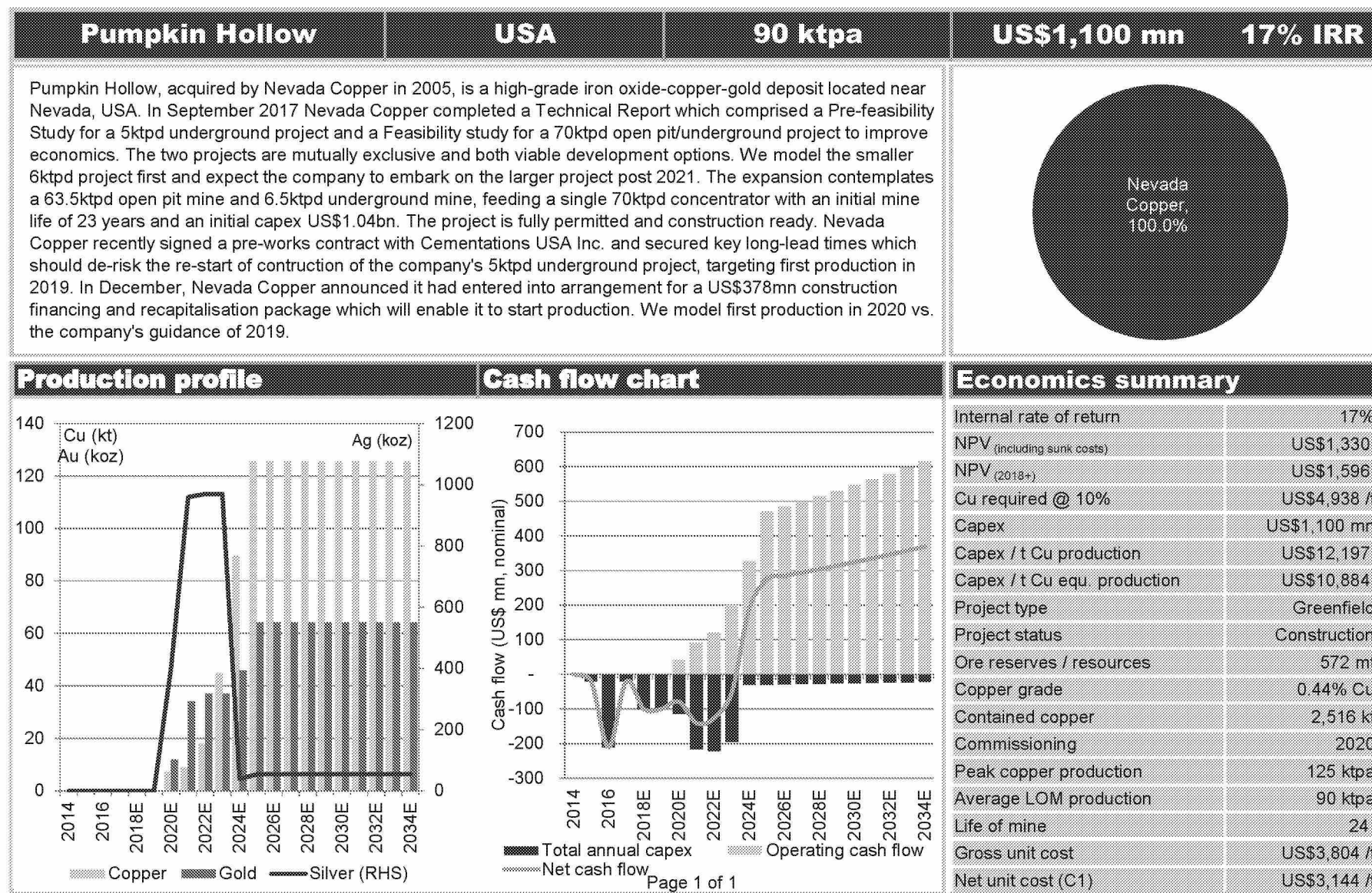
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 145: Pulang



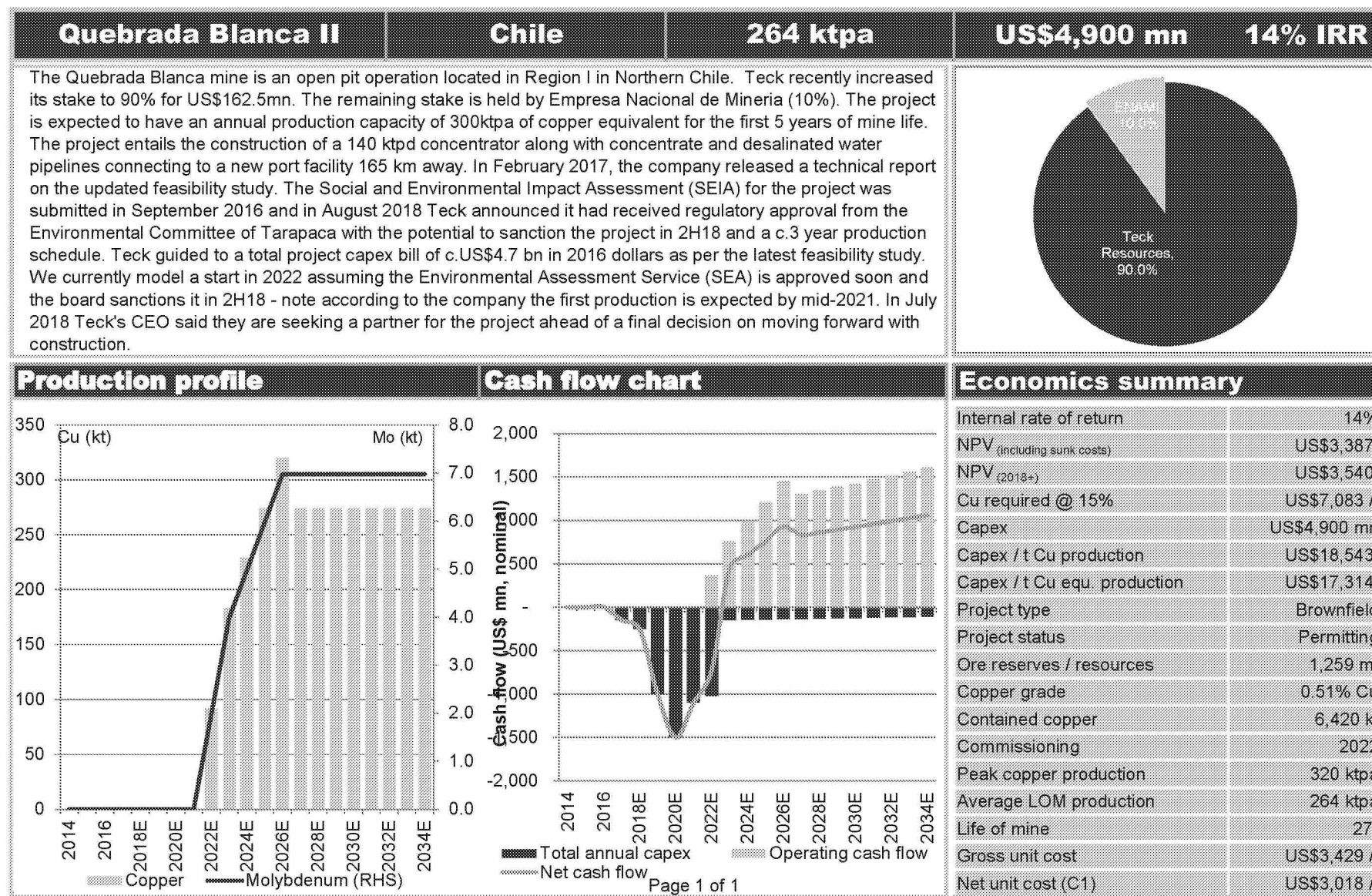
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 146: Pumpkin Hollow



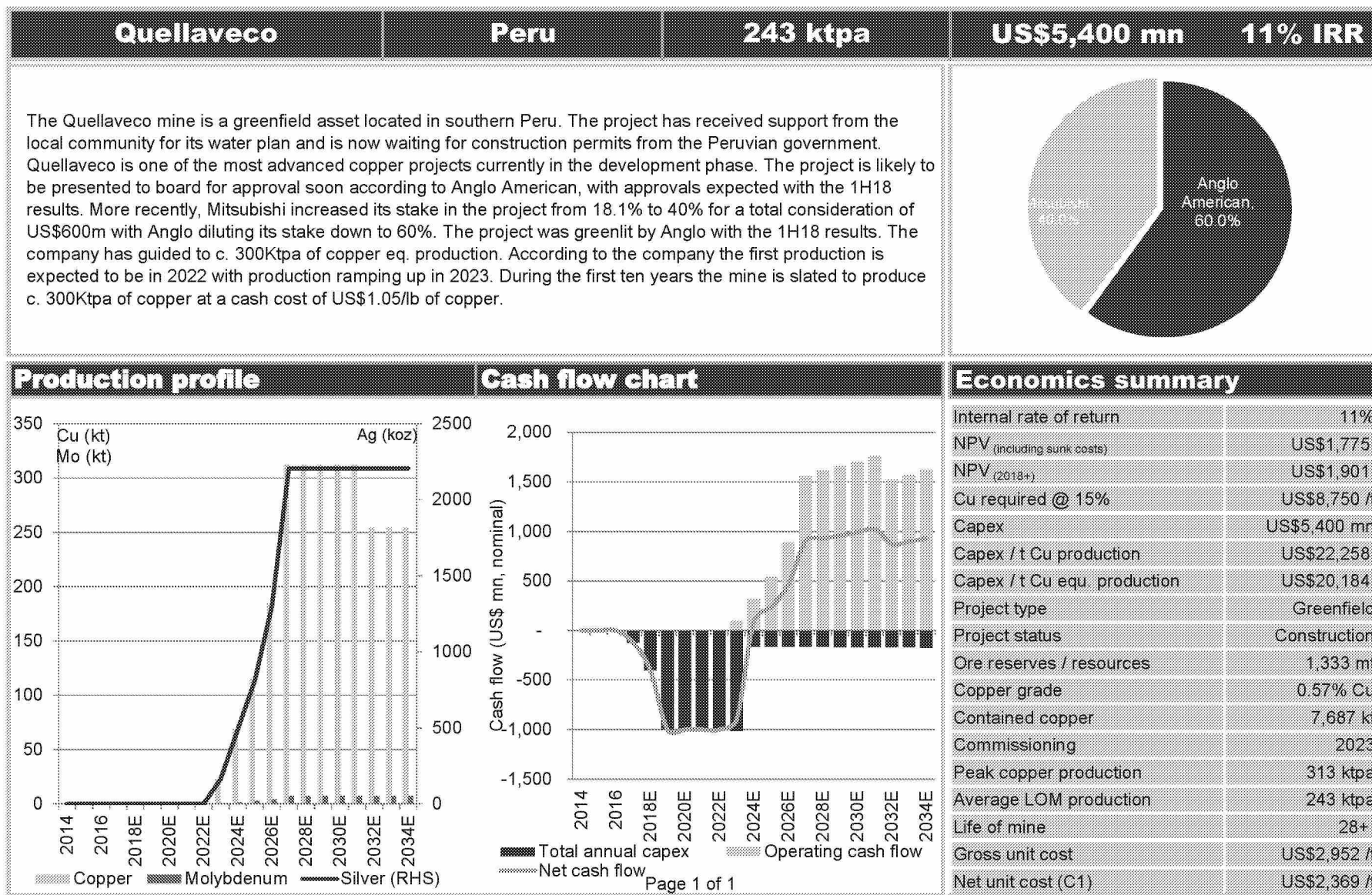
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 147: Quebrada Blanca II



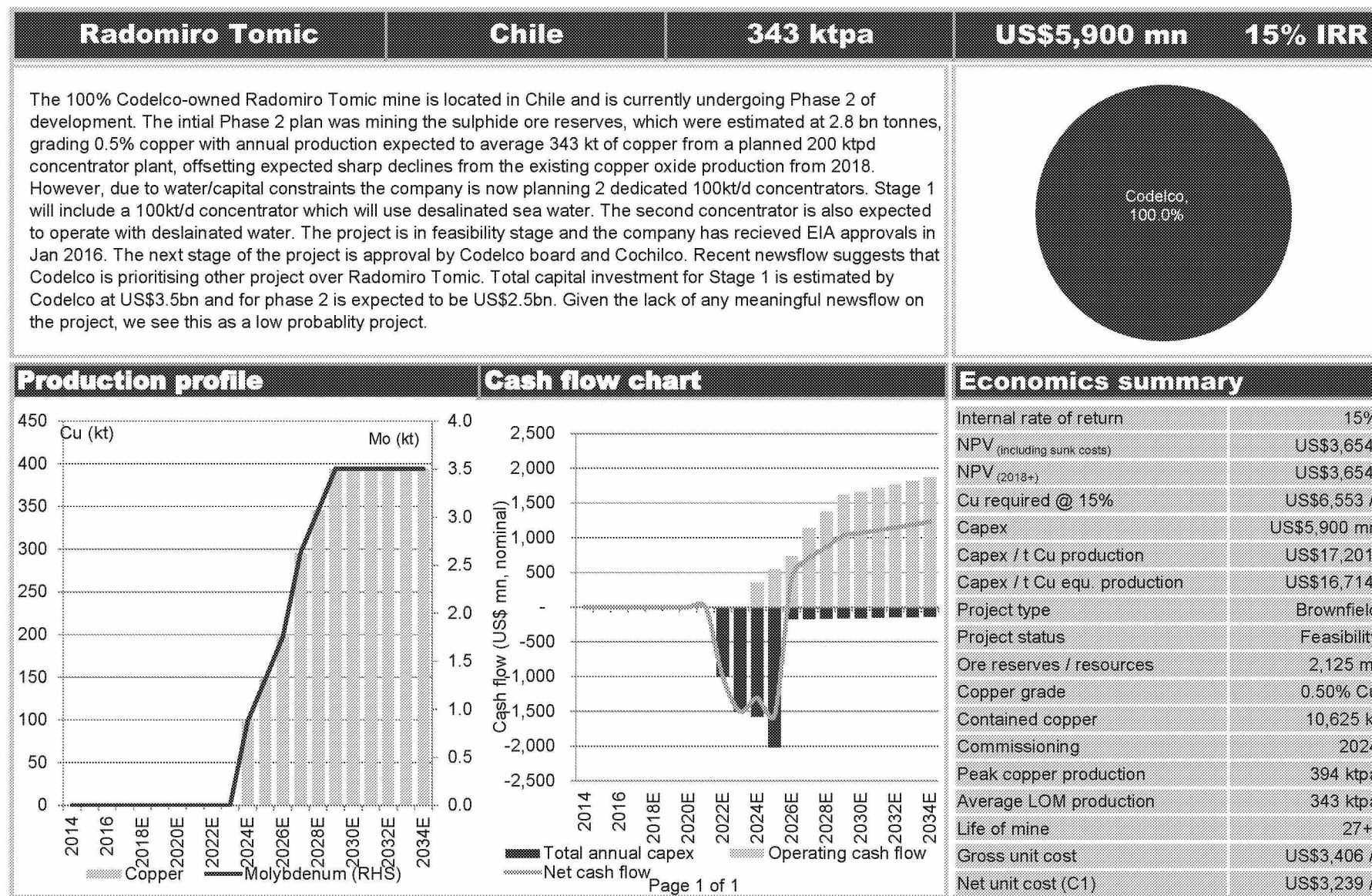
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 148: Quellaveco



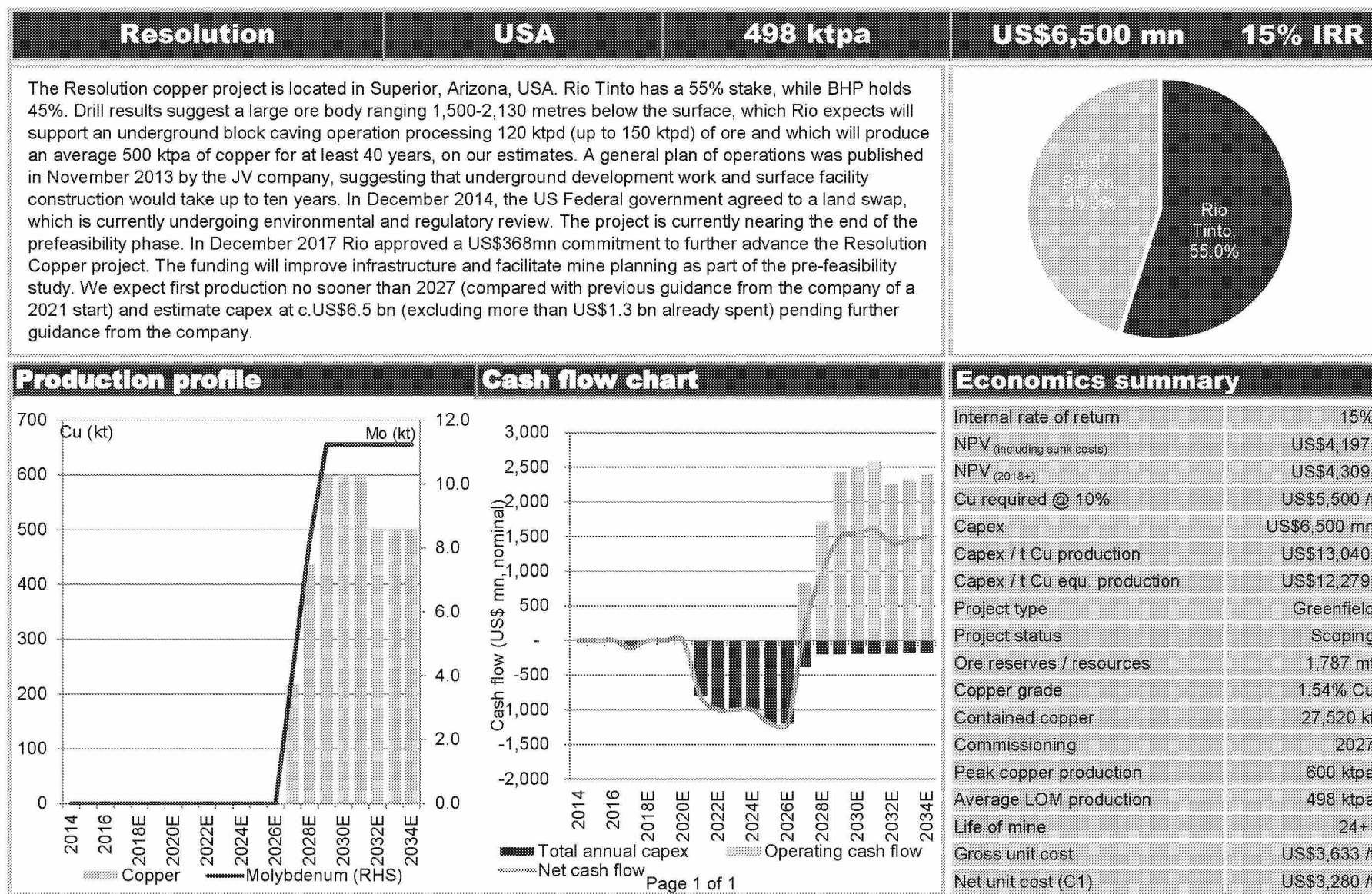
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 149: Radomiro Tomic



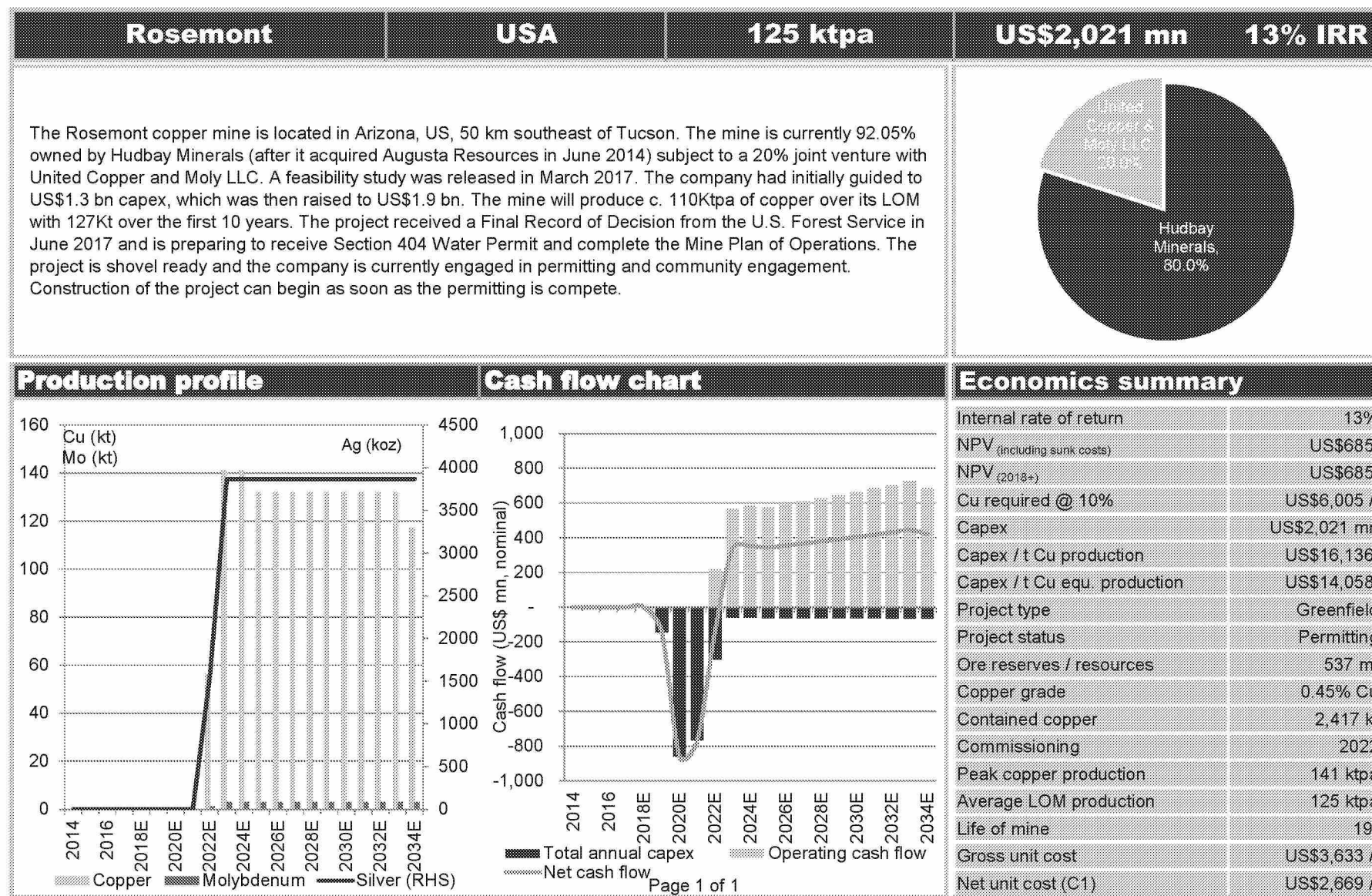
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 150: Resolution



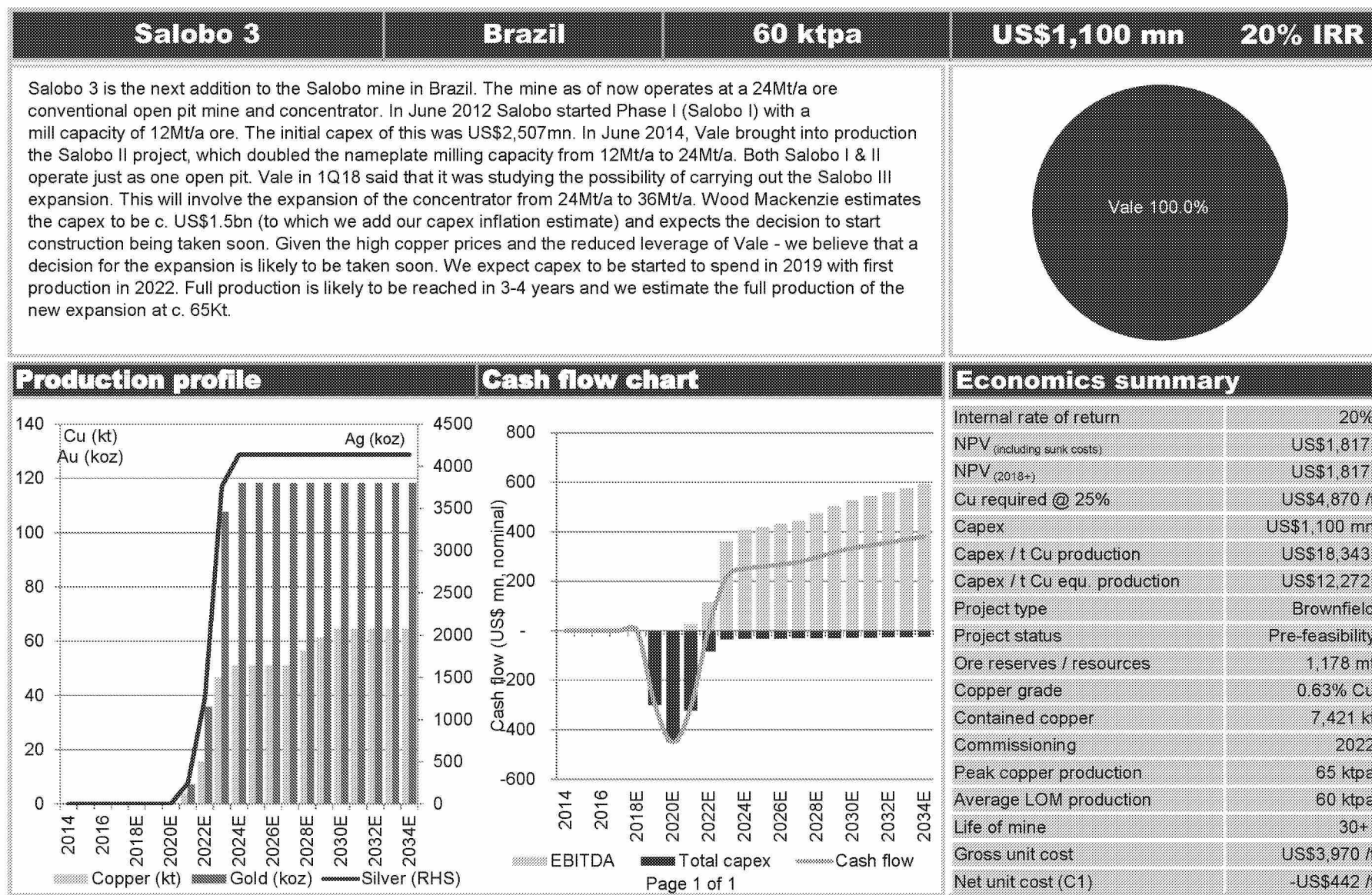
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 151: Rosemont



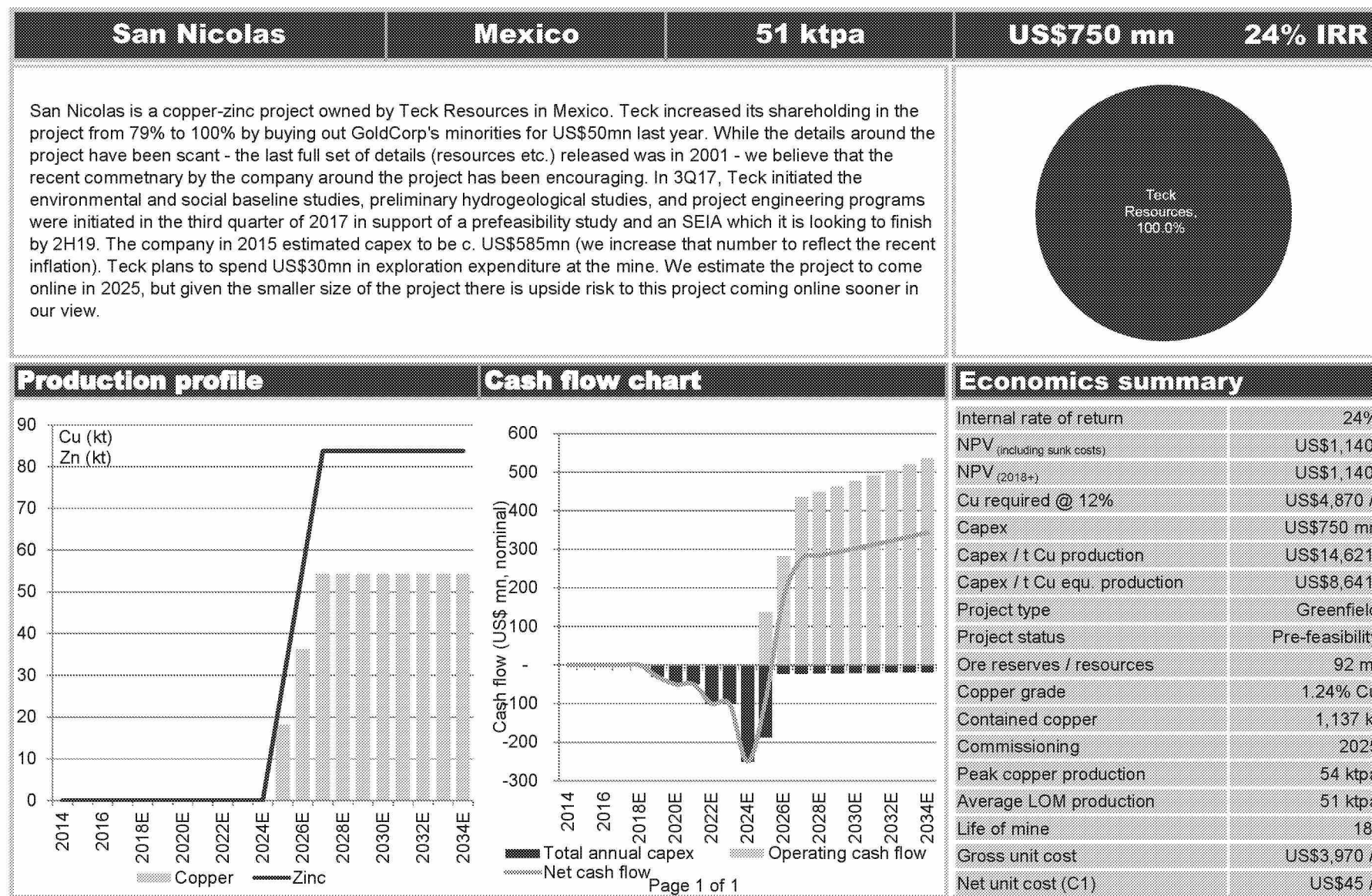
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 152: Salobo 3



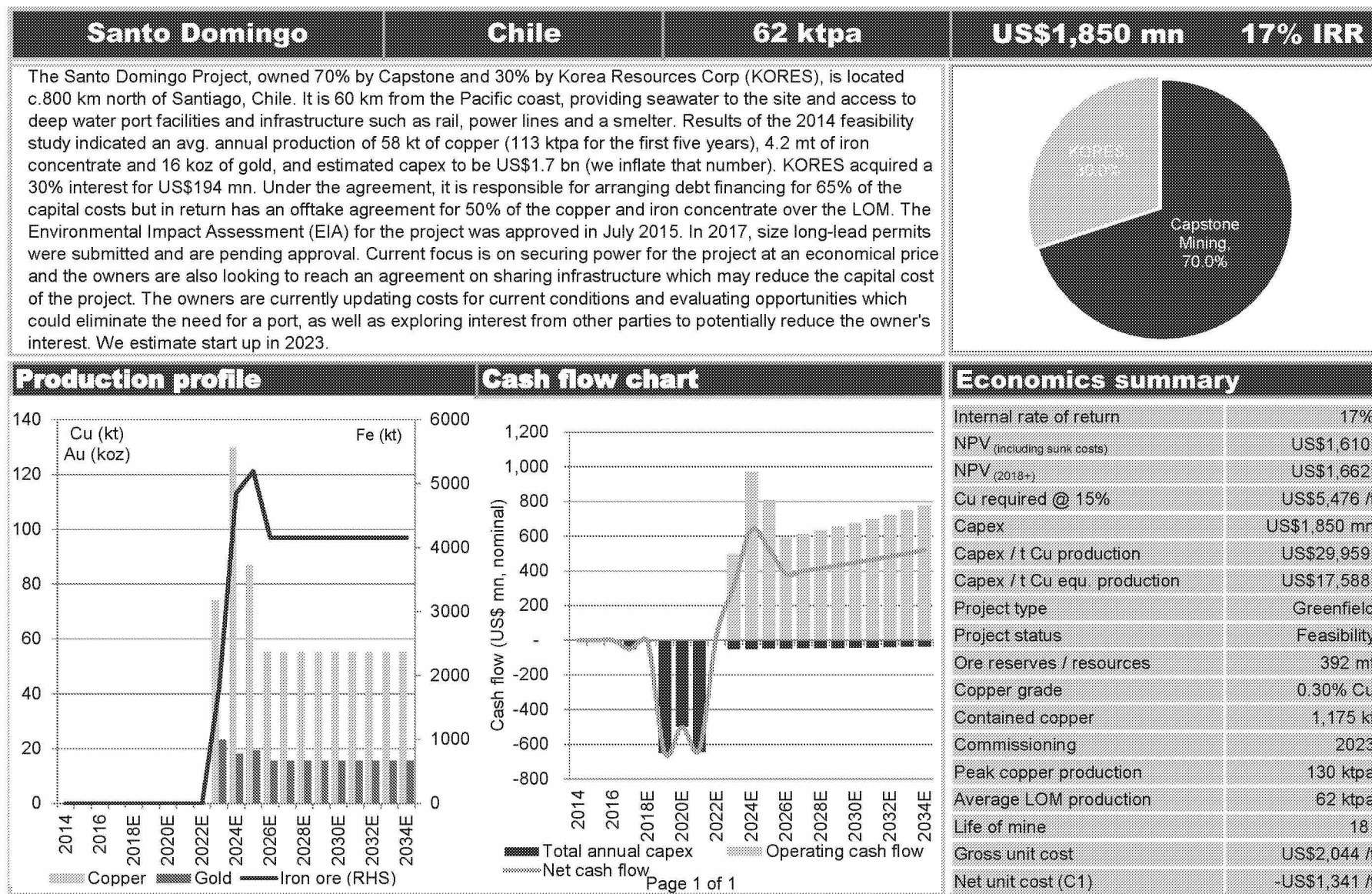
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 153: San Nicolas



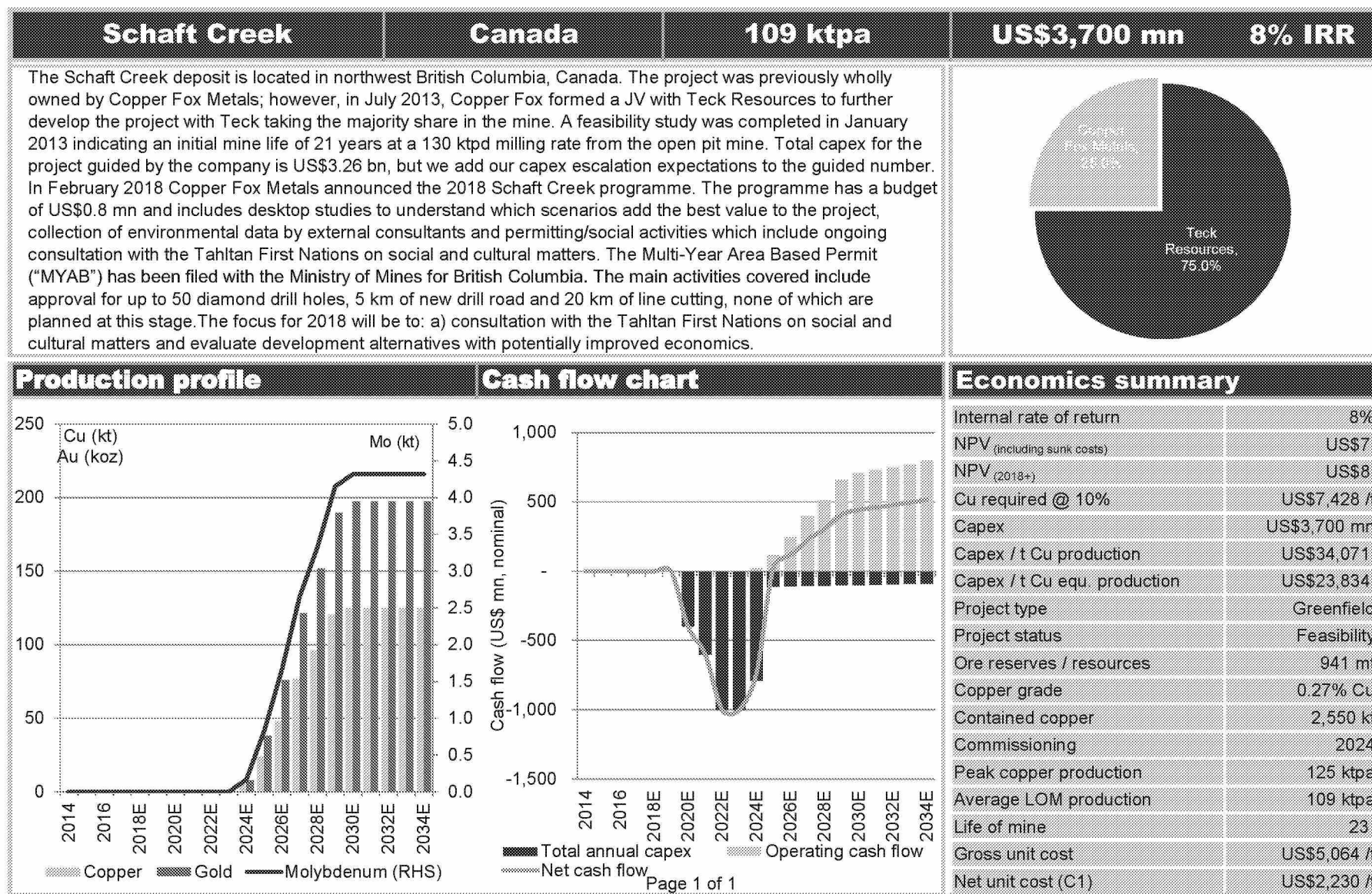
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 154: Santo Domingo



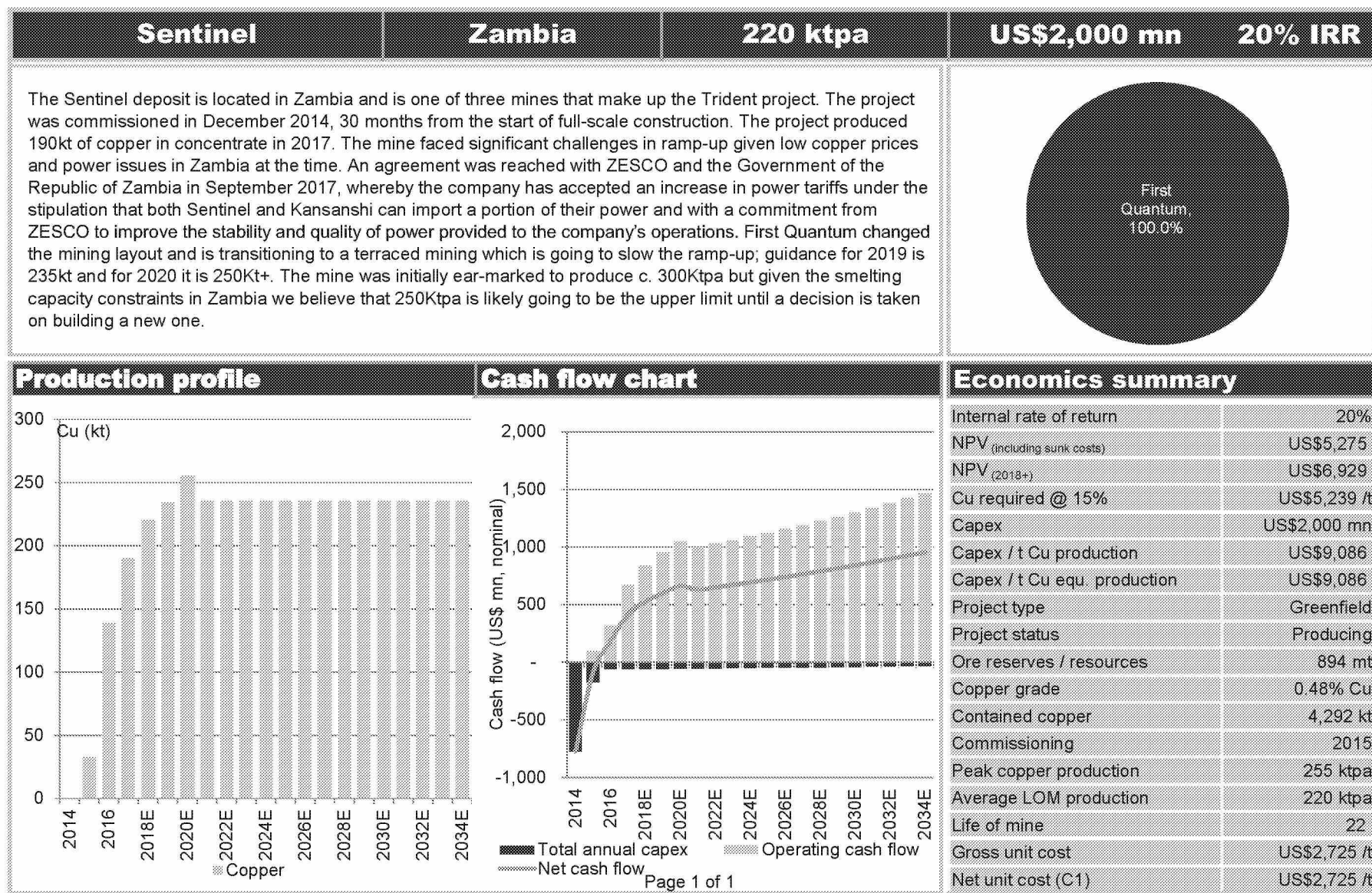
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 155: Schaft Creek



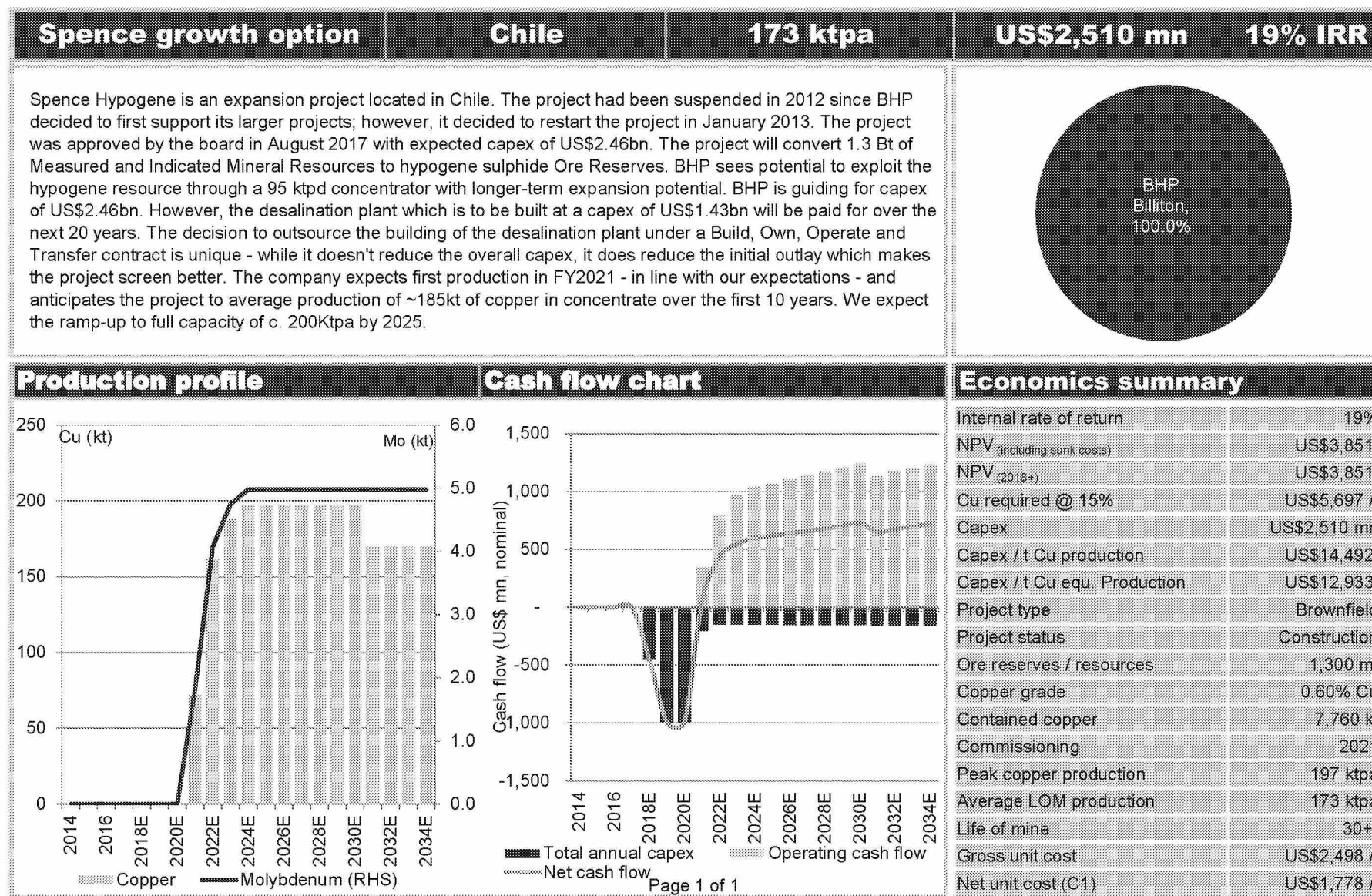
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 156: Sentinel



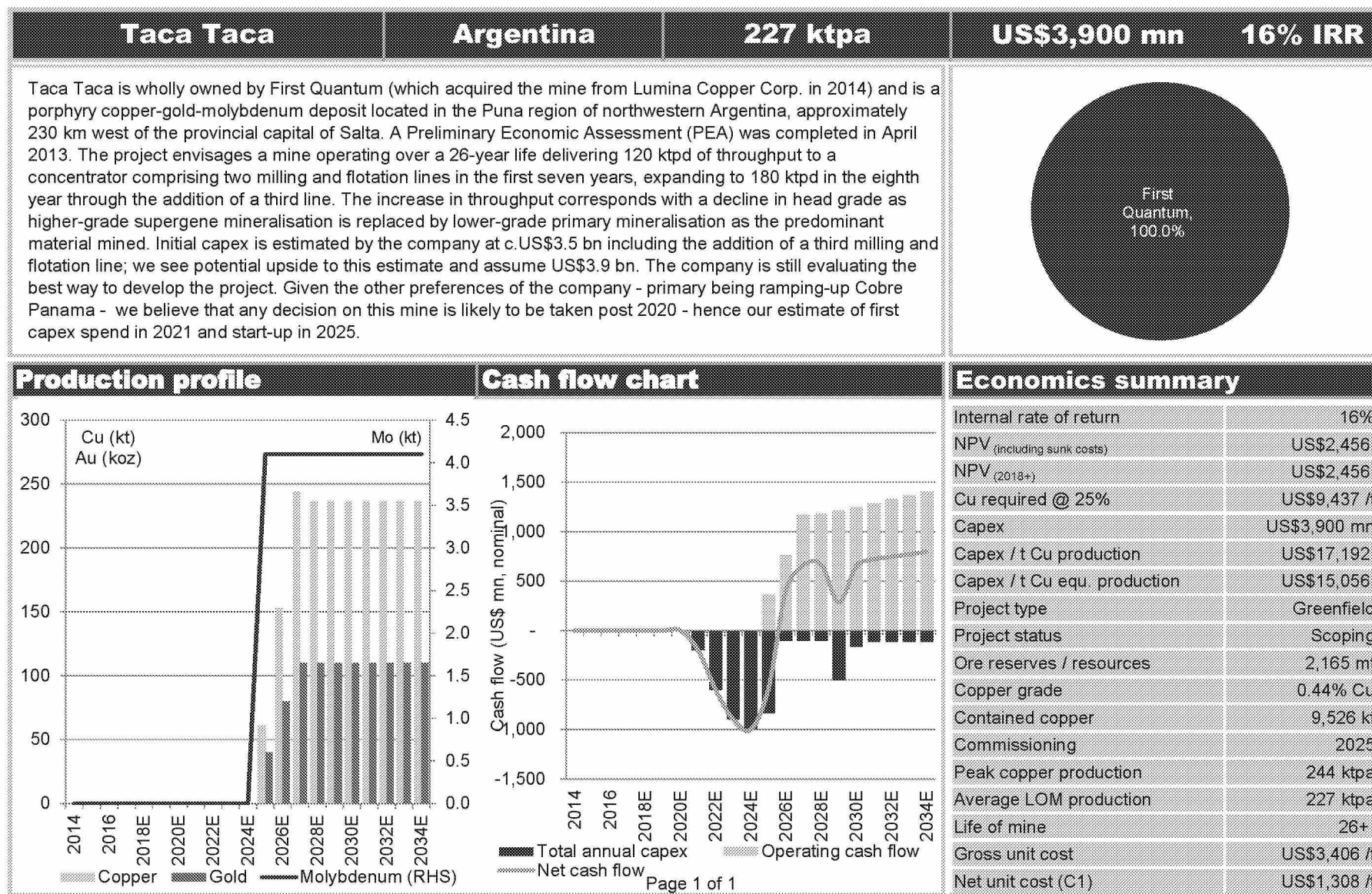
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 157: Spence growth option



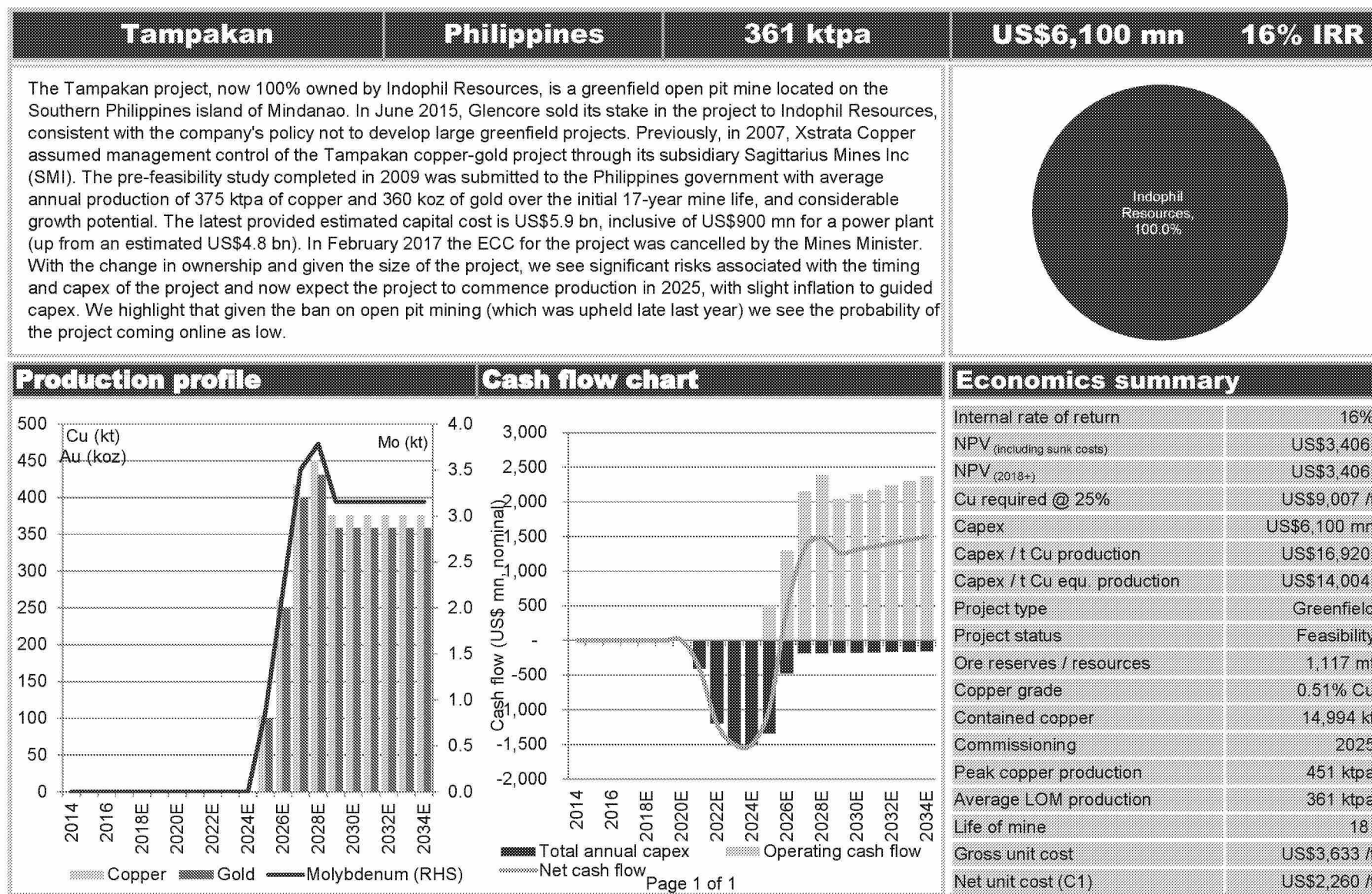
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 158: Taca Taca



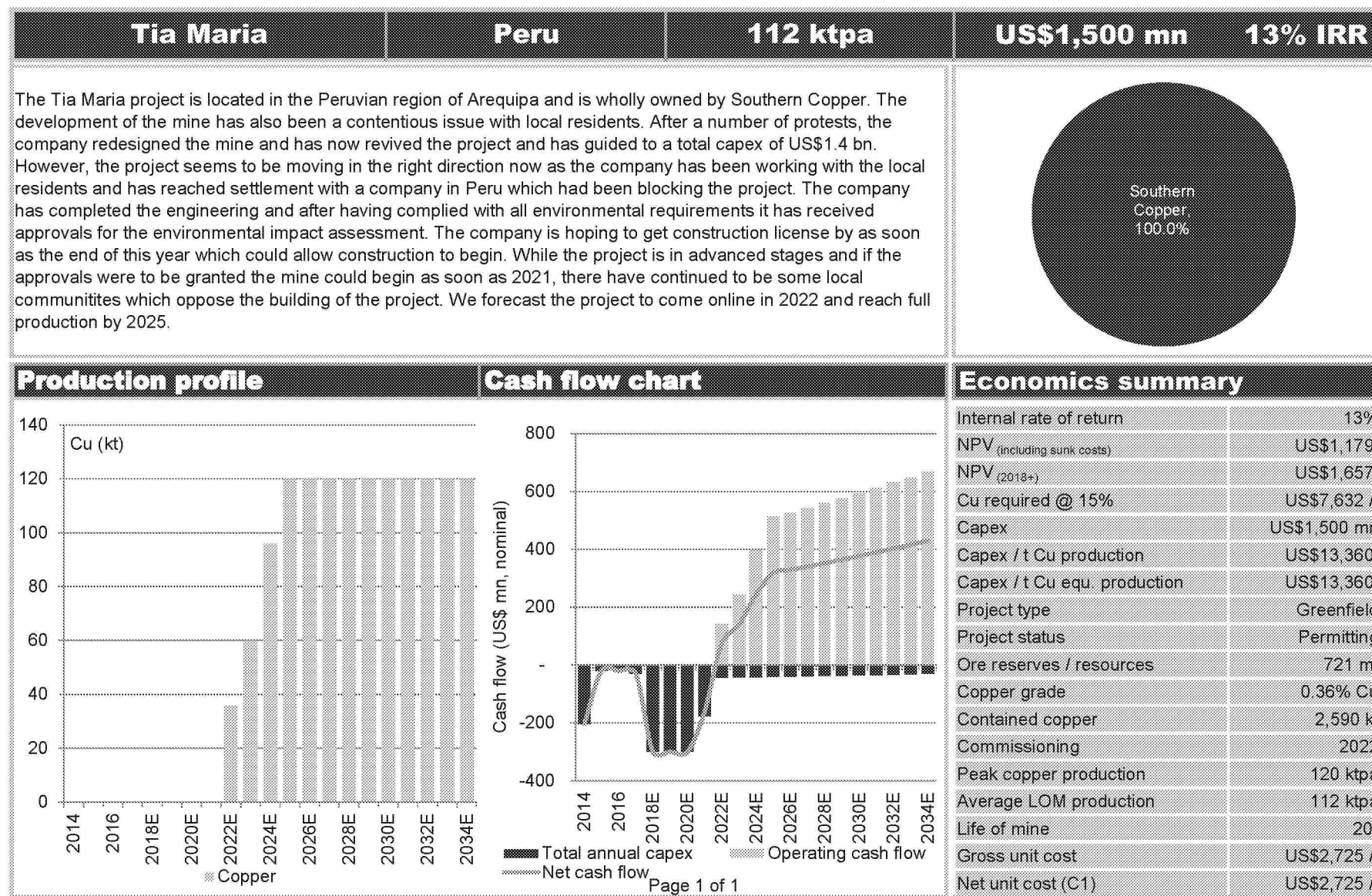
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 159: Tampakan



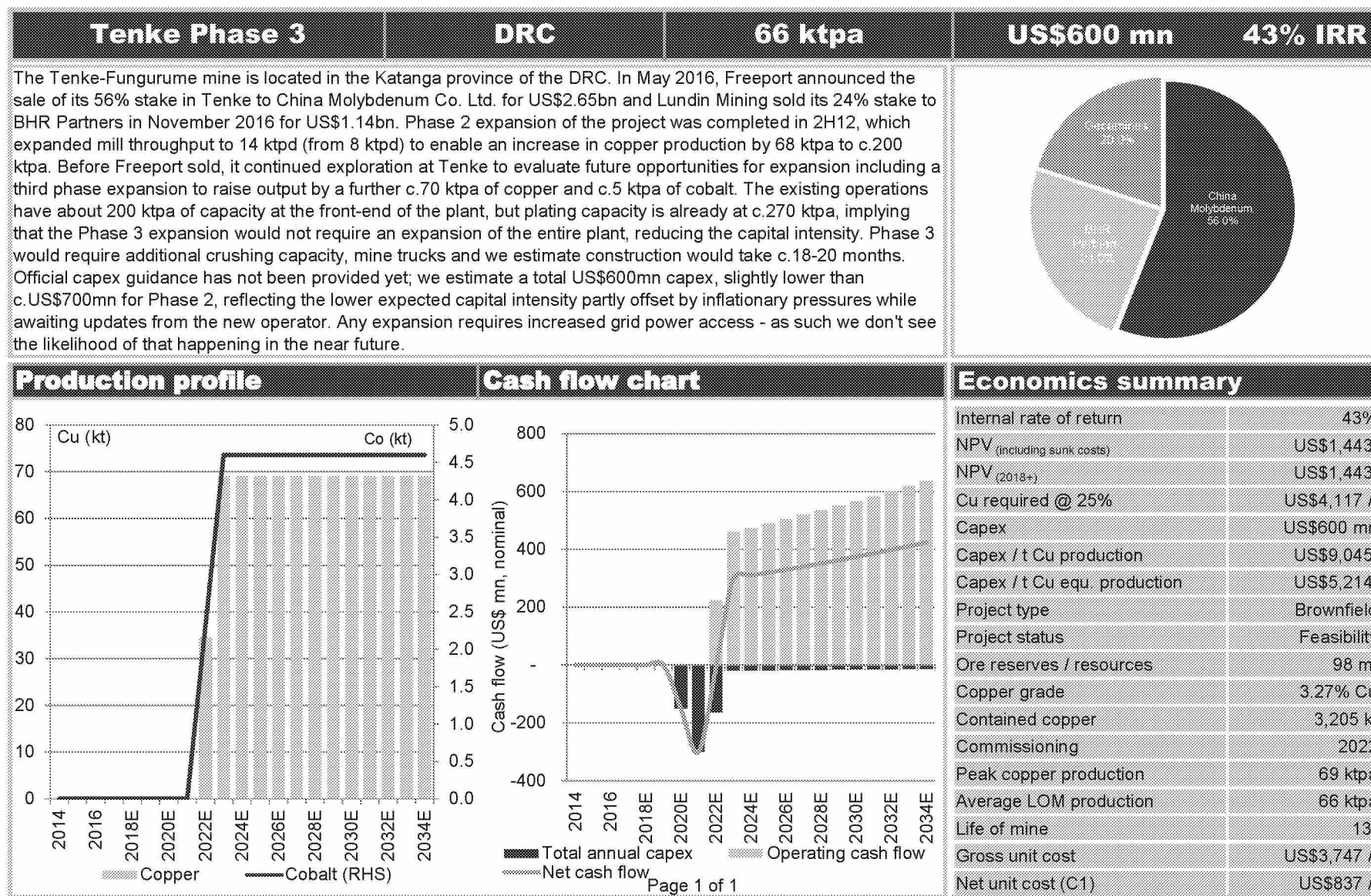
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 160: Tia Maria



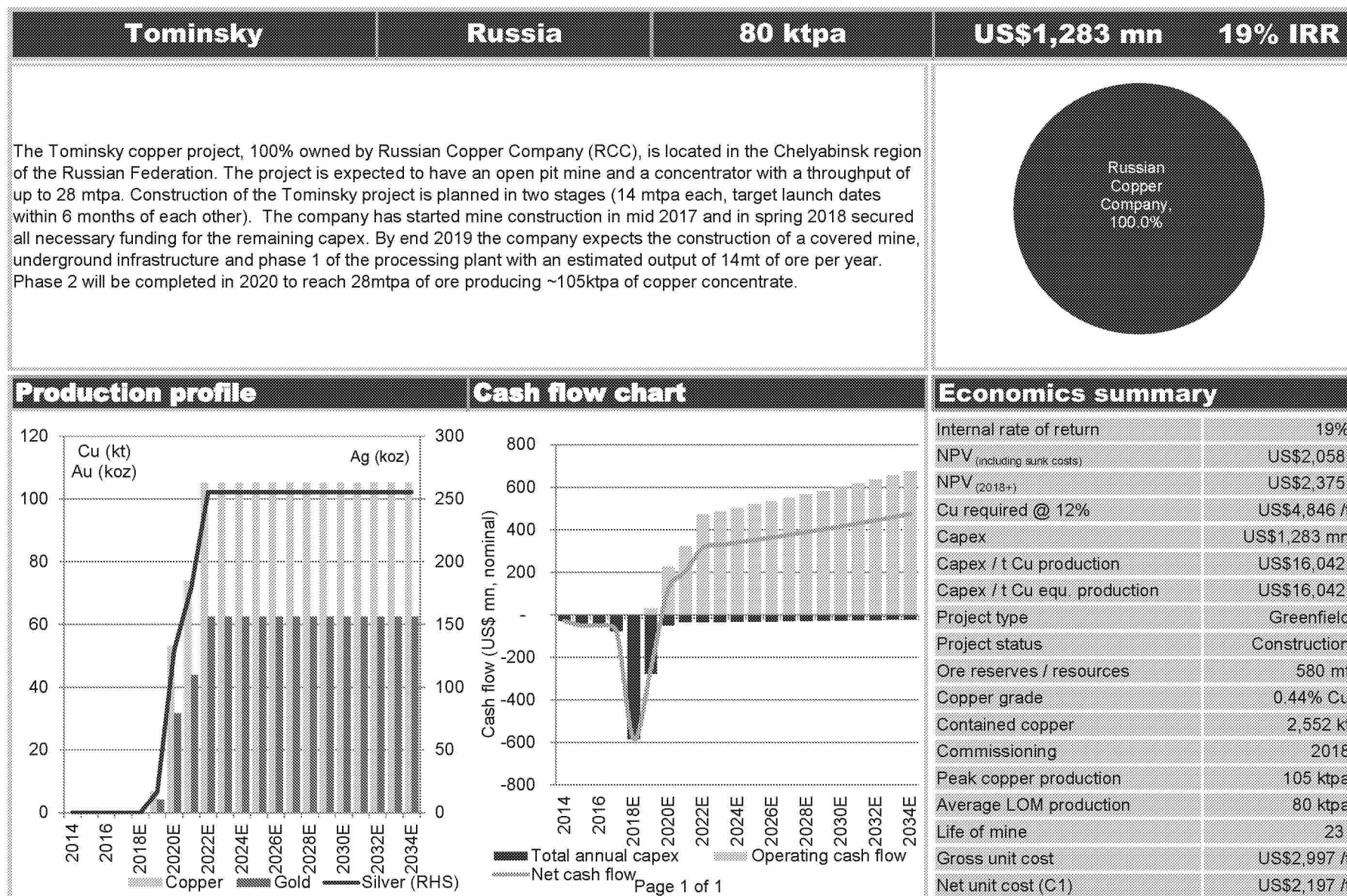
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 161: Tenke Phase 3



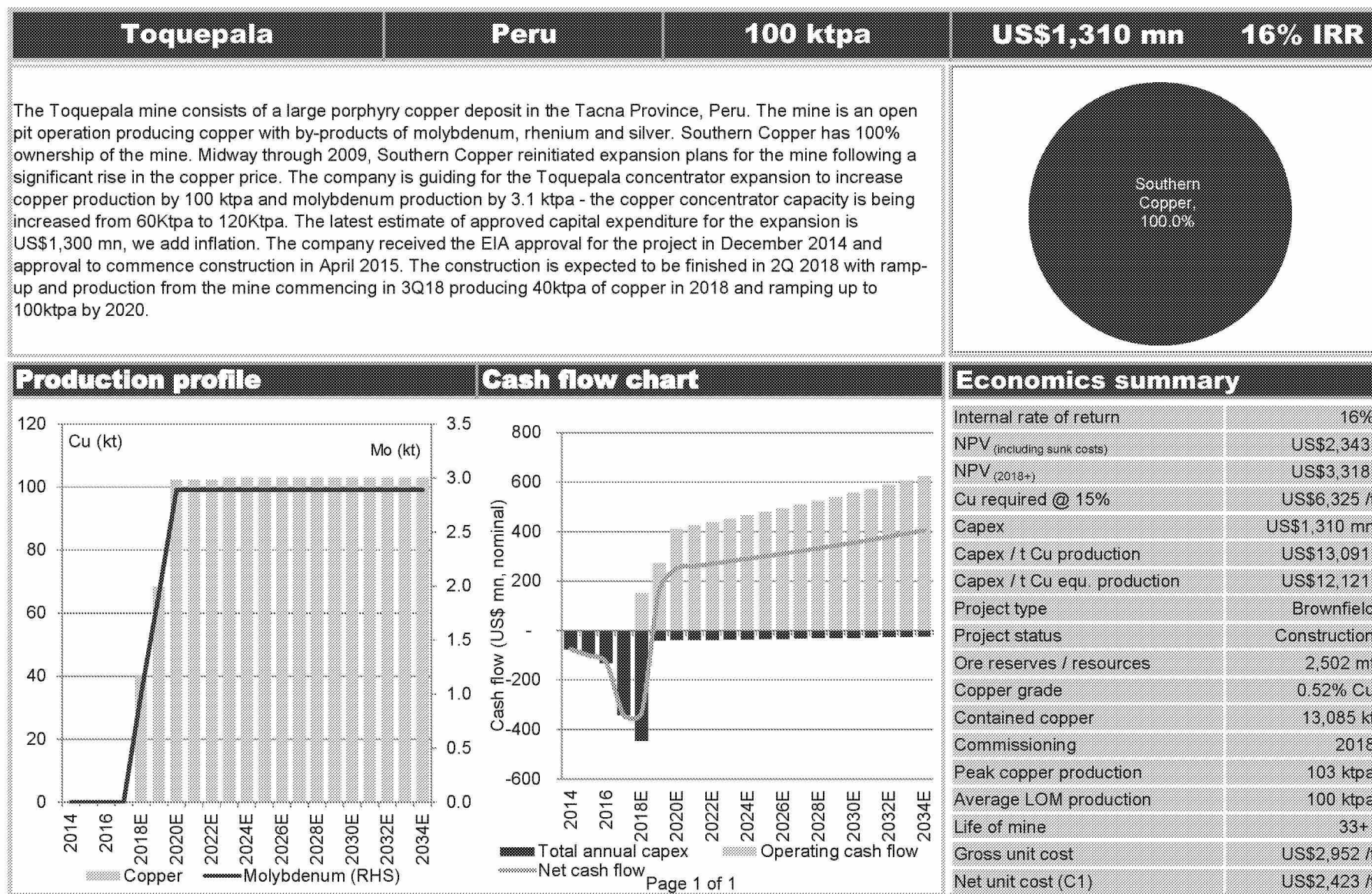
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 162: Tominsky



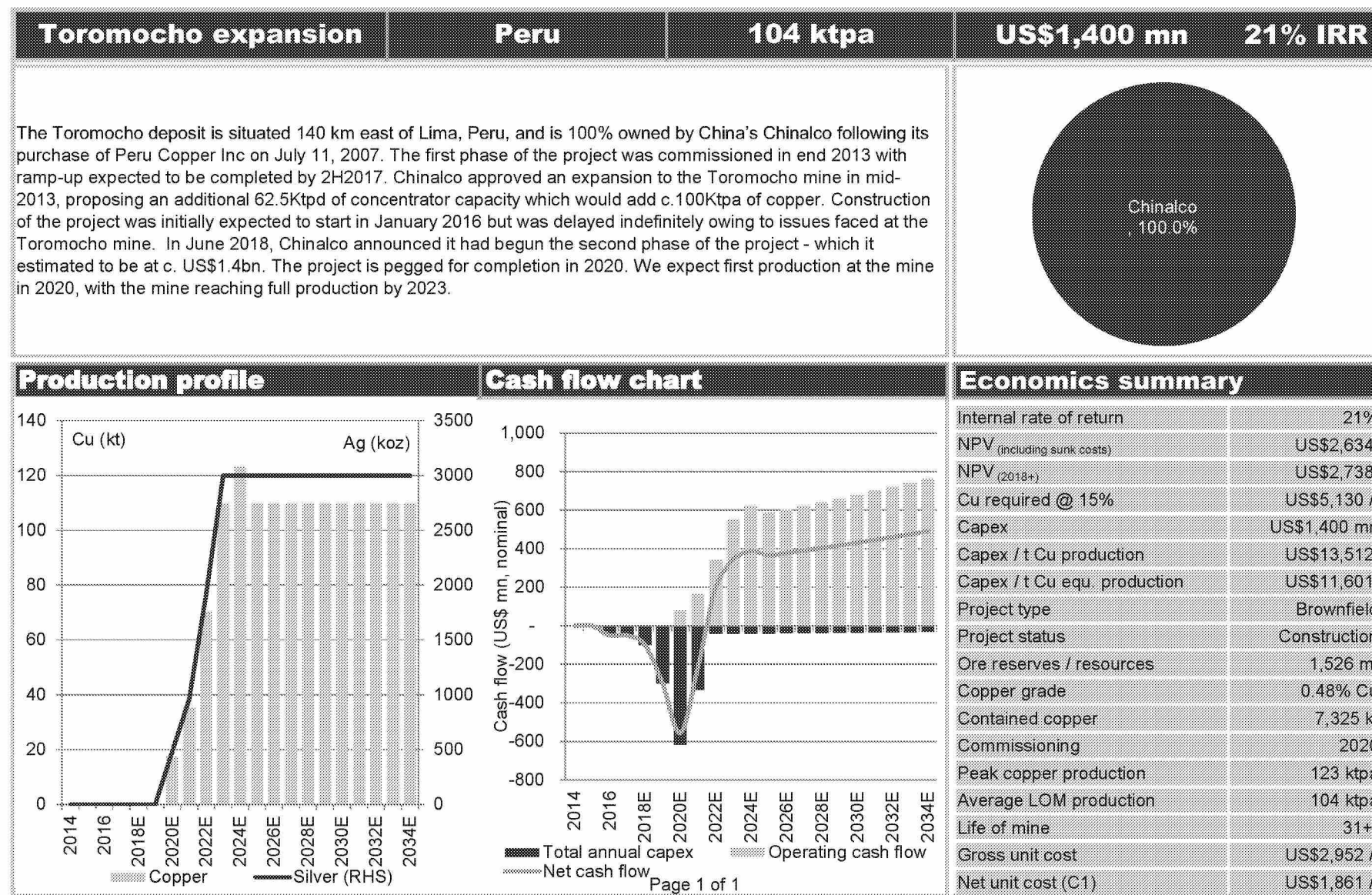
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 163: Toquepala



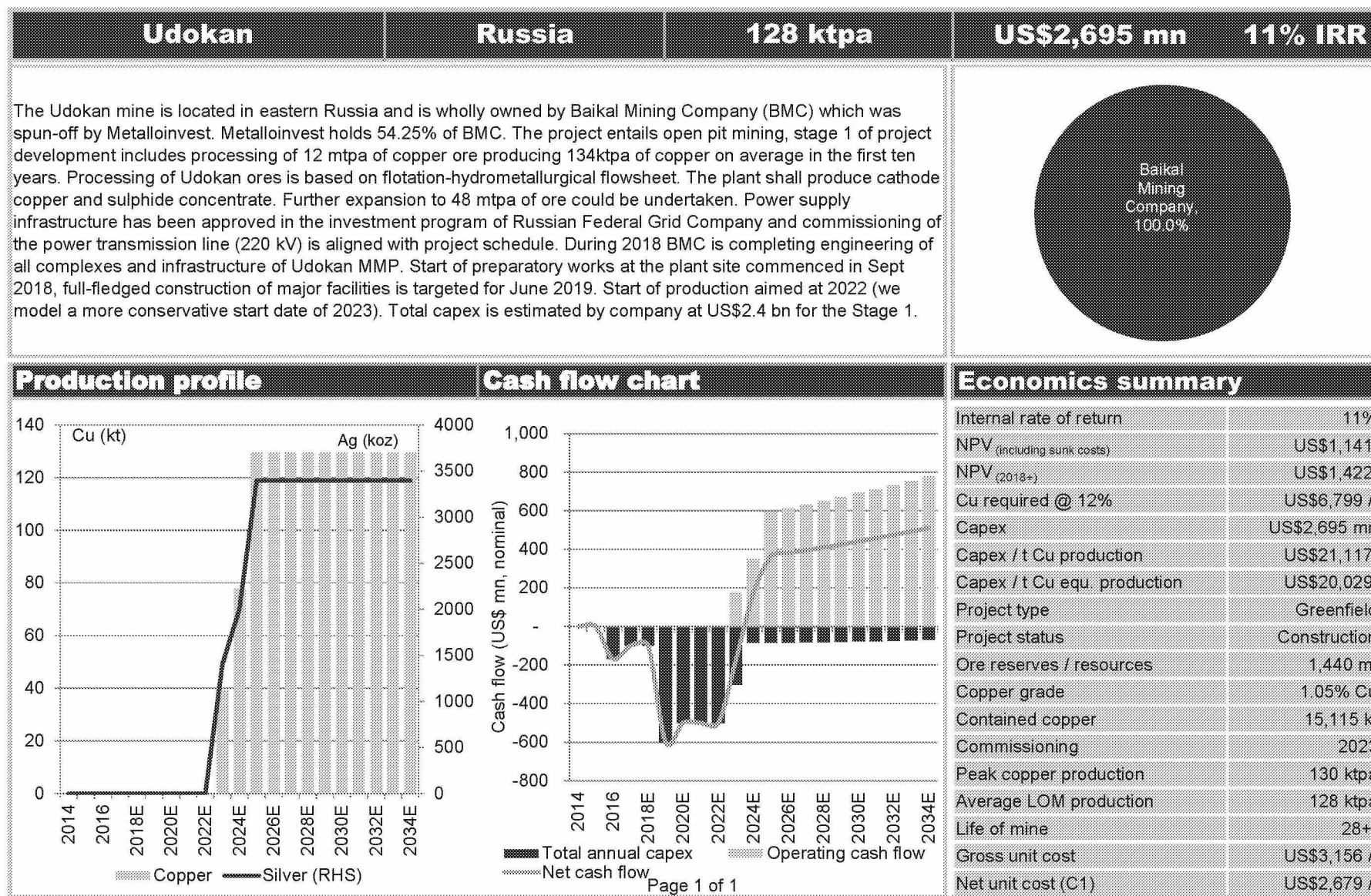
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 164: Toromocho expansion



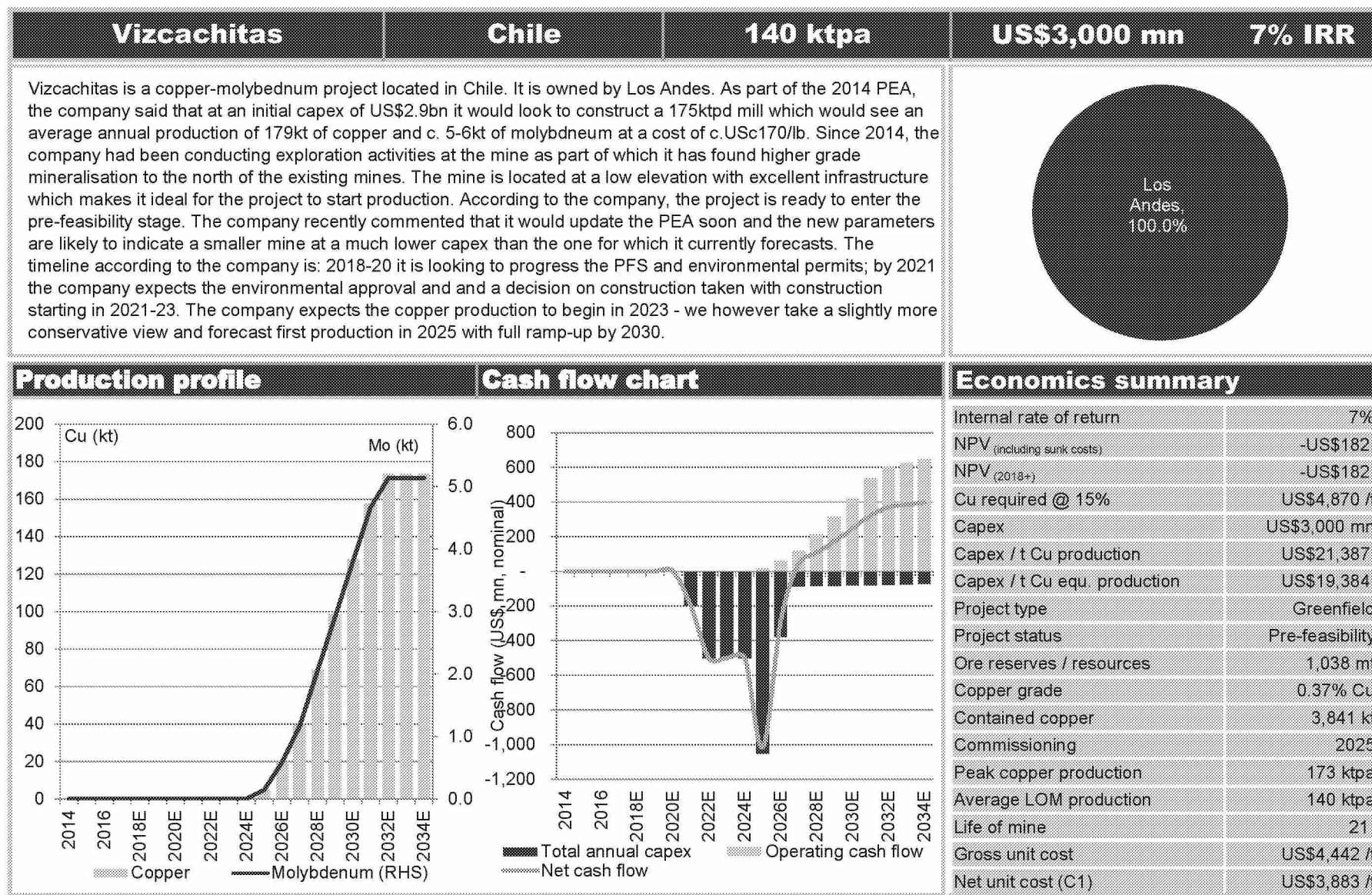
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 165: Udokan



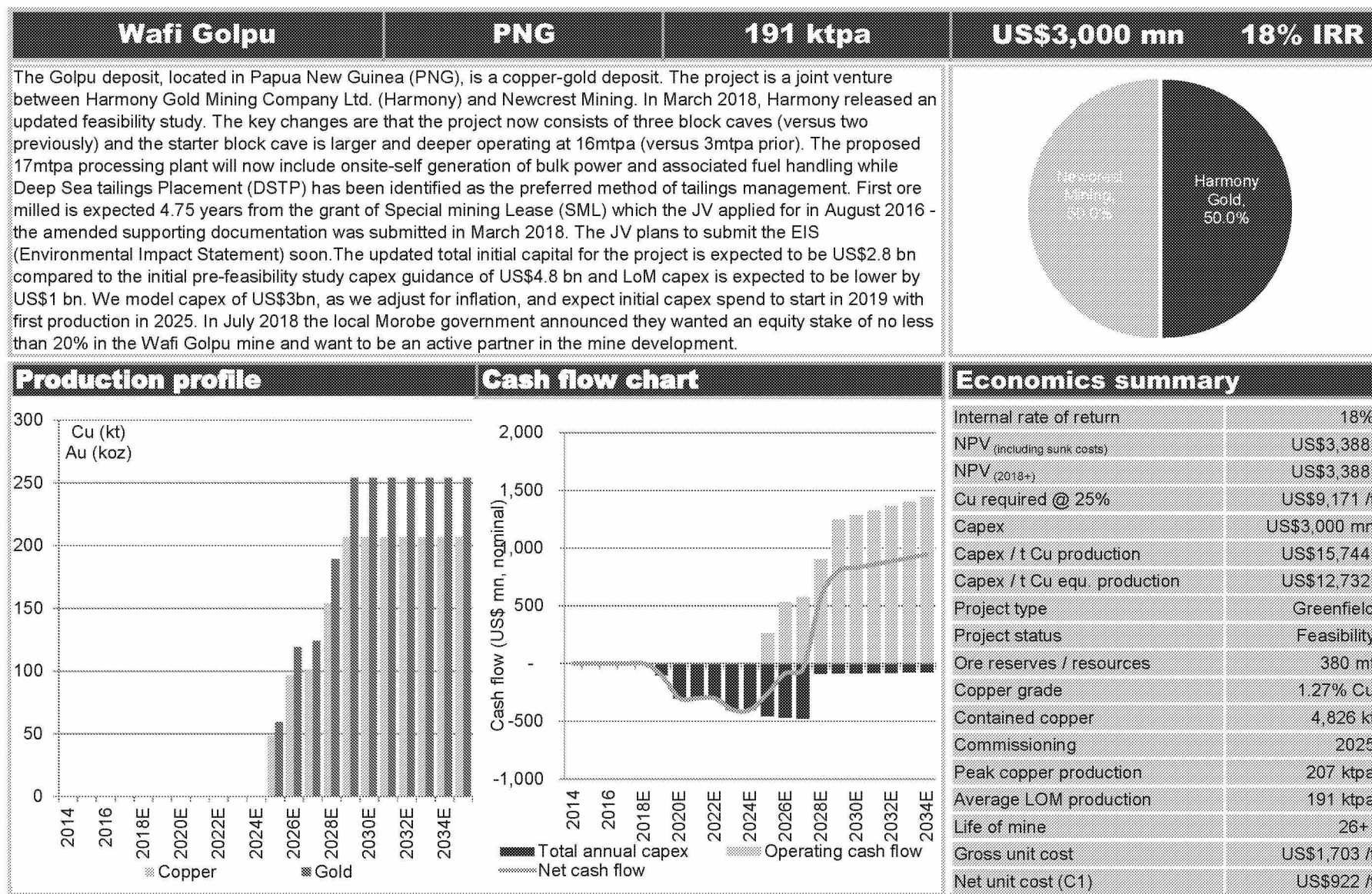
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 166: Vizcachitas



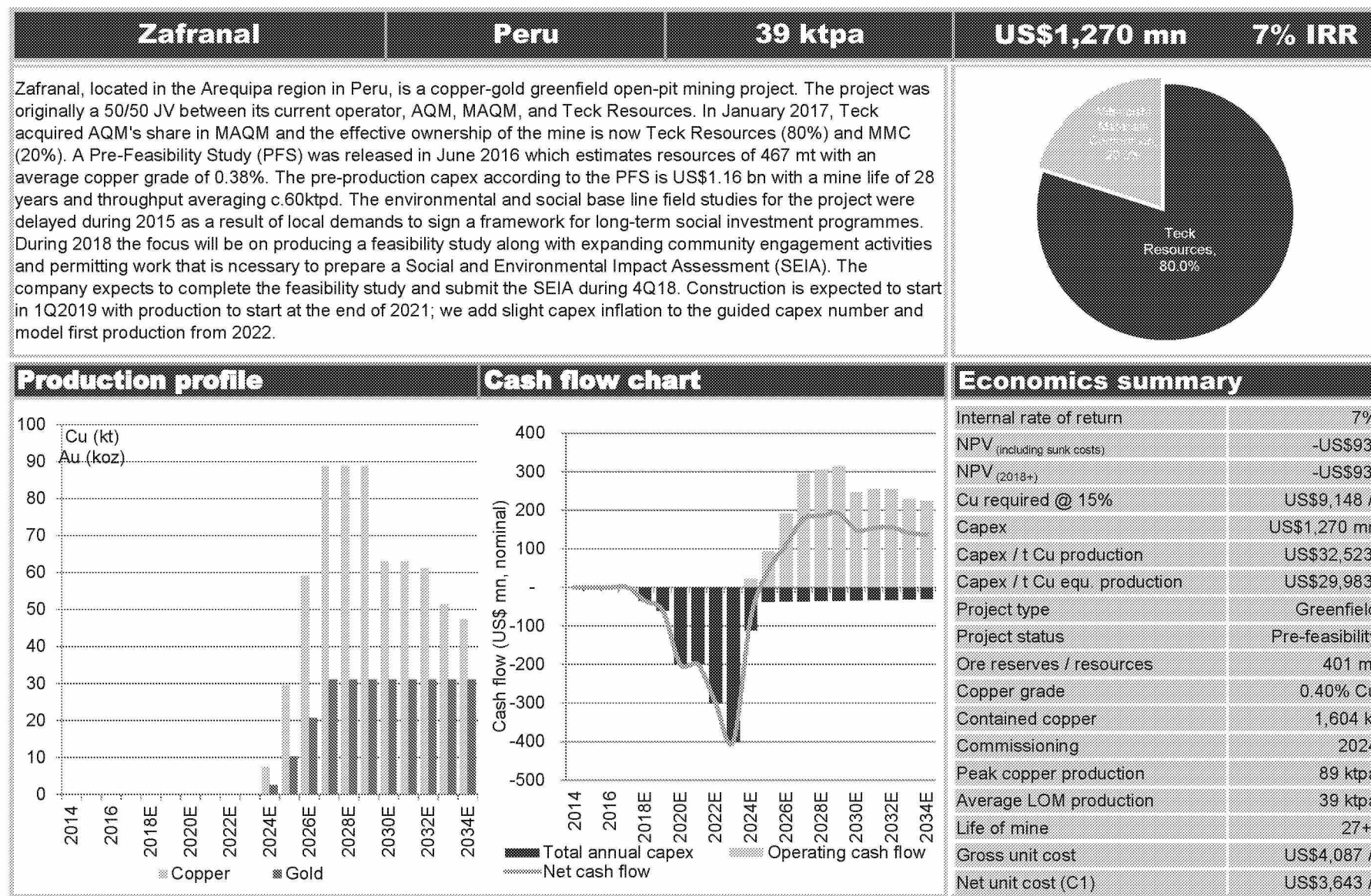
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 167: Wafi Golpu



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 168: Zafranal



Source: Company data, Goldman Sachs Global Investment Research

Share prices in this report are based on the market close of October 3, 2018.

EPS change summary

Exhibit 169: Summary of EPS changes

Company	EPS						% Change		
	2018E		2019E		2020E		2018E	2019E	2020E
Diversifieds	New	Old	New	Old	New	Old			
BHP - LSE	1.24	1.24	1.56	1.40	1.30	1.24	0%	11%	5%
BHP - ASX	1.24	1.24	1.56	1.40	1.30	1.24	0%	11%	5%
Rio -LSE	5.22	5.03	4.83	4.84	4.30	4.27	4%	0%	1%
Rio Tinto - ASX	5.22	5.03	4.83	4.84	4.30	4.27	4%	0%	1%
Glencore	0.53	0.54	0.51	0.60	0.40	0.48	-1%	-15%	-17%
Anglo American	2.26	2.24	2.23	2.23	1.77	1.73	1%	0%	2%
Norilsk Nickel	2.45	2.56	2.55	2.76	2.43	2.63	-4%	-8%	-7%
Teck Resources Ltd.	4.46	4.92	3.63	4.16	3.04	3.58	-9%	-13%	-15%
Copper									
Antofagasta	0.39	0.42	0.80	1.17	0.93	1.24	-7%	-31%	-25%
Boliden	25.73	26.12	25.63	29.29	23.95	26.78	-1%	-12%	-11%
First Quantum Minerals	0.52	0.55	1.00	1.33	1.46	1.81	-6%	-25%	-19%
Lundin Mining Corp.	0.34	0.35	0.57	0.73	0.70	0.85	-3%	-21%	-18%
KAZ Minerals Plc	0.94	0.97	0.76	1.18	0.73	1.10	-3%	-35%	-34%
Aurubis AG	5.19	5.19	3.86	4.40	4.67	5.32	0%	-12%	-12%
KGHM Polska Miedz SA	9.25	10.01	11.09	6.02	8.15	2.69	-8%	84%	202%
Freeport-McMoRan Inc.	1.58	1.78	0.74	1.39	0.94	1.60	-11%	-47%	-41%
MMG Ltd	0.03	0.05	0.06	0.09	0.07	0.09	-30%	-33%	-25%
Jiangxi Copper	0.73	0.83	0.79	0.98	0.83	1.00	-12%	-19%	-17%
Zijin Mining	0.18	0.20	0.19	0.24	0.21	0.26	-9%	-20%	-17%

Source: Goldman Sachs Global Investment Research

Financial advisory disclosure

Goldman Sachs and/or one of its affiliates is acting as a financial advisor in connection with an announced strategic matter involving the following company or one of its affiliates: BHP Billiton Limited, BHP Billiton Plc

Disclosure Appendix

Reg AC

We, Eugene King, Abhinandan Agarwal, Trina Chen, Matthew Korn, CFA, Joy Zhang and Nina Dergunova, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

GS Factor Profile

The Goldman Sachs Factor Profile provides investment context for a stock by comparing key attributes to the market (i.e. our coverage universe) and its sector peers. The four key attributes depicted are: Growth, Financial Returns, Multiple (e.g. valuation) and Integrated (a composite of Growth, Financial Returns and Multiple). Growth, Financial Returns and Multiple are calculated by using normalized ranks for specific metrics for each stock. The normalized ranks for the metrics are then averaged and converted into percentiles for the relevant attribute. The precise calculation of each metric may vary depending on the fiscal year, industry and region, but the standard approach is as follows:

Growth is based on a stock's forward-looking sales growth, EBITDA growth and EPS growth (for financial stocks, only EPS and sales growth), with a higher percentile indicating a higher growth company. **Financial Returns** is based on a stock's forward-looking ROE, ROCE and CROCI (for financial stocks, only ROE), with a higher percentile indicating a company with higher financial returns. **Multiple** is based on a stock's forward-looking P/E, P/B, price/dividend (P/D), EV/EBITDA, EV/FCF and EV/Debt Adjusted Cash Flow (DACF) (for financial stocks, only P/E, P/B and P/D), with a higher percentile indicating a stock trading at a higher multiple. The **Integrated** percentile is calculated as the average of the Growth percentile, Financial Returns percentile and (100% - Multiple percentile).

Financial Returns and Multiple use the Goldman Sachs analyst forecasts at the fiscal year-end at least three quarters in the future. Growth uses inputs for the fiscal year at least seven quarters in the future compared with the year at least three quarters in the future (on a per-share basis for all metrics).

For a more detailed description of how we calculate the GS Factor Profile, please contact your GS representative.

M&A Rank

Across our global coverage, we examine stocks using an M&A framework, considering both qualitative factors and quantitative factors (which may vary across sectors and regions) to incorporate the potential that certain companies could be acquired. We then assign a M&A rank as a means of scoring companies under our rated coverage from 1 to 3, with 1 representing high (30%-50%) probability of the company becoming an acquisition target, 2 representing medium (15%-30%) probability and 3 representing low (0%-15%) probability. For companies ranked 1 or 2, in line with our standard departmental guidelines we incorporate an M&A component into our target price. M&A rank of 3 is considered immaterial and therefore does not factor into our price target, and may or may not be discussed in research.

Quantum

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GS SUSTAIN

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Eugene King: Australia-Resources, EMEA Mining - Precious, Europe-Mining, Europe-Steel. Abhinandan Agarwal: EMEA Mining - Precious. Trina Chen: A-share Basic Materials, China Basic Materials. Matthew Korn, CFA: America-Metals & Mining. Joy Zhang: A-share Basic Materials, China Basic Materials. Nina Dergunova: CEEMEA (ex-MENA) Basic Materials.

A-share Basic Materials: Aluminum Corp. of China (A), Angang Steel (A), Anhui Conch Cement (A), Baoshan Iron & Steel, BBMG Corp. (A), China Coal Energy (A), China Molybdenum Co. (A), Jiangxi Copper (A), Maanshan Iron & Steel (A), Yanzhou Coal Mining (A), Zijin Mining (A).

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Australia-Resources: BHP Billiton, Rio Tinto, South32 Ltd..

CEEMEA (ex-MENA) Basic Materials: Alrosa, Erdemir, Evraz Plc, KGHM Polska Miedz SA, Magnitogorsk Steel, Norilsk Nickel, Novolipetsk Steel, PhosAgro, PJSC Polyus, Polymetal International Plc, Severstal.

China Basic Materials: Aluminum Corp. of China (H), Angang Steel (H), Anhui Conch Cement (H), BBMG Corp. (H), China Coal Energy (H), China Hongqiao Group, China Molybdenum Co. (H), China National Building Material, China Resources Cement Holdings, Jiangxi Copper (H), Lee & Man Paper Manufacturing Ltd., Maanshan Iron & Steel (H), MMG Ltd, Nine Dragons Paper Holdings, West China Cement, Yanzhou Coal Mining (H), Zhaojin Mining Industry, Zijin Mining (H).

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Goldman Sachs Investment Research global Equity coverage universe

	Rating Distribution				Investment Banking Relationships		
	Buy	Hold	Sell		Buy	Hold	Sell
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